R E P O R T R E S U M E S

ED 003 536 56

AN INVESTIGATION OF THE INPROVEMENT OF EDUCATIONAL MOTION PICTURES AND A DERIVATION OF PRINCIPLES RELATING TO THE EFFECTIVENESS OF THESE MEDIA.

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REPORT NUMBER NDEA-VIIA-225 PUB DATE APR 65
GRANT OEG-736048
EDRS PRICE MF-$0.18 HC-$3.80 95P.

DESCRIPTORS- *MEDIA RESEARCH, *INSTRUCTIONAL FILMS, *FILM PRODUCTION, *SCIENCE INSTRUCTION, TEACHING TECHNIQUES, *COMPARATIVE ANALYSIS, TEST CONSTRUCTION, UNIVERSITY PARK, PENNSYLVANIA, WHY FOODS SPOIL, ATOMS AND MOLECULES

THIS RESEARCH INVOLVED THE SELECTION OF TWO EXTANT TEACHING FILMS, DEVELOPMENT OF TESTS ON THEIR CONTENT, REVISION OF THE FILMS, AND A COMPARISON OF THE TWO VERSIONS. THE FILMS SELECTED WERE "WHY FOODS SPOIL" AND "ATOMS AND MOLECULES." THE SUBJECTS CONSISTED OF STUDENTS IN SMALL TOWN SCHOOLS FROM 5TH TO 12TH GRADES. MULTIPLE-CHOICE TEST ITEMS WERE CONSTRUCTED AND ADMINISTERED TO REPRESENTATIVE GROUPS OF STUDENTS WHO HAD SEEN THE APPROPRIATE FILMS. DATA WERE USED TO IMPROVE THE ORIGINAL FILMS. THE REVISED VERSIONS WERE PRESENTED TO ONE-HALF OF EACH GROUP. TESTING SESSIONS WERE HELD TO COMPARE THE ORIGINAL AND REVISED VERSIONS. THE DATA WERE ANALYZED TO COMPARE MEAN SCORES BETWEEN VERSIONS AND TO COMPARE PROPORTIONS SELECTING VARIOUS ALTERNATIVES IN EACH MULTIPLE-CHOICE ITEM. THE MEAN SCORES INDICATED THAT THE REVISIONS IMPROVED THE EFFECTIVENSS OF THE FILM, BUT SOME OF THE TEST ITEMS WERE FOUND TO HAVE NO RELEVANCE TO THE REVISIONS. (RS)

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APRIL, 1965

ED 003536

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CHAPTER I

THE PROBLEM AND METHOD OF INVESTIGATION

The problem investigated in the research study reported herein is this: to what extent can teaching films be improved by systematically modifying their structure and their elements based on the results of tests which are designed to identify those portions or elements of the films from which the school audience derives relatively little information. It was anticipated that some principles of production might be educed or additional statistical support derived for existing principles in the process of the investigation. The feasibility of cooperative action between commercial film producers and University research workers would also be tested.

Research completed prior to 1950 in the general area of film production variables has been summarized by Hoban and Van Ormer,[1] who devote most of a chapter to this subject. Additional research in this area has been reported in the publications of the Instructional Film Research Project[2] of The Pennsylvania State University. Additional research has more recently been completed and is in progress at Ohio State University (Guba)[3] and American Institute for Research.[4] The present research was commenced prior to the major endeavors represented by the Guba and AIR studies and is reported here in the content of these studies in that they, in contrast with previous studies, deal with the teaching film as an organic whole rather than concentrating on meticulously defined single variables or groups of variables. The wholistic approach was followed in the investigation being reported herein.

The procedure followed in this research involved, in essence, the selection of two extant teaching films, development of analytical tests on their content, revising the films on the basis of the results of these tests and comparing revised and original versions of the films in terms of test data gathered from comparable groups of subjects.

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(1) Hoban, C. F., and Van Ormer, E. B., Instructional Film Research: 1918-1950. Tech. Report No. SDC 269-7-19, NAVEXOS p. 977. Special Devices Center, Port Washington, New York

(2) Technical Report No. SDC 269-7-36, NAVEXOS p. 1220. Vols. I and II. Special Devices Center. Pt. Washington, New York.

(3) Gropper, George L., and Lumsdaine, Arthur A. An Experimental Comparison of a Conventional TV Lesson with a Programmed TV Lesson Requiring Active Student Response. Pittsburgh: American Institute for Research, 1961.

(4) Reference is made here to studies of eye movements of student subjects viewing pictorial devices.

The films selected were "Why Foods Spoil" and"Atoms and Molecules," produced by Encyclopaedia Britannica Films. Each was considered by the producers to be of at least adequate quality in terms of their educational effectiveness.

The subjects used for the research were students in schools in small towns in Central Pennsylvania. Cell class groups used were considered as normal by teachers and supervisors. The grade levels of the subjects ranged from grade 5 to grade 12. Data on age, sex, grade level, and number of these subjects are presented in Table I. Data on the intelligence of the experimental subjects are presented as part of Table II.

After several viewings of the films, the investigators began to construct multiple choice test items that would cover as completely as possible the informational content of the films. When the individual members of the research team agreed that the number of plausible test items that they could write on the films was exhausted, a series of staff conferences were held in which the final preliminary version of the film test was put together. This preliminary version was then administered to what was considered to be representative groups of students after they had seen the appropriate films in a classroom situation. None of the subjects who were used in this phase of the investigation were from the same school system as those subjects used in the subsequent comparative phases of the investigation. Data thus gathered were used in constructing the final versions of the film tests. These final versions ranged in length from 68 to 80, as shown in Table III. The reliability coefficients[1] ranged from .76 to .84. Copies of the tests may be found in Appendixes C-D.

During the test construction phase of the study, many ideas for the possible improvement of the original films were generated. Comparison of data on the proportion of subjects selecting various alternatives in the multiple choice test furnished clues to additional possible changes. Using the ideas originating from these sources as particular referents and bearing in mind the results of previous film studies, a series of staff conferences were held in which a revised script was agreed upon for each film. It was not the intent to write an entirely new film on each subject, in fact, it was the intent to use the content of the original film as a base and to change the film only by improving scenes and narration while retaining the basic original format. Numerous additional scenes were added, however. Many more scenes were retaken and much of the narration was changed. Appendixes B, F, H include original scripts and revised scripts.

(1) Kuder-Richardson Formula 20.

TABLE 1

CHARACTERISTICS OF SUBJECTS

Film Project	Number Male	Number Female	Total	Age Range	Grade Range
WHY FOODS SPOIL					
Project I					
Test Development	56	54	109	9-11	5
	47	53	100	12-15	8
	34	43	77	14-17	10
Film Evaluation	42	23	65	9-11	5
	49	49	98	12-15	8
	29	56	85	14-17	10
Comparison Data					
Original Film	41	50	91	10-12	5
	50	44	94	12-14	7
	53	43	96	16-18	11
Revised Film	42	50	92	10-12	5
	52	43	95	12-14	7
	64	39	103	16-18	9
WHY FOODS SPOIL					
Project II					
Original Film	32	37	69	8-13	5-6
	44	41	85	13-17	8
	37	32	69	16-17	10-11-12
Second Revision	31	39	70	10-13	5-6
	44	39	83	13-15	8
	44	31	75	15-19	10-11-12
ATOMS AND MOLECULES					
Test Development	12	10	22	9-12	4-5-6
Film Evaluation	17	14	31	9-10	5
	17	16	33	12-13	8
	12	19	31	15-16	11
Comparison Data					
Original Film	38	33	71	10-13	5-6
	37	34	71	12-18	7
	22	39	61	14-18	10
Revised Film	40	33	73	10-13	5-6
	37	36	73	12-14	7
	24	35	59	14-18	10

TABLE II

COMPARISONS OF GROUPS SEEING ORIGINAL AND REVISED VERSIONS OF MOTION PICTURES

Film Project	Number of Subjects: Male Original	Male Revised	Female Original	Female Revised	Total Original	Total Revised	Intelligence: Mean Raw Scores: Orig.	Rev.	Diff.	Standard Error Diff.	Achievement on Film Tests: Mean Raw Scores: Orig.	Rev.	Diff.	Standard Error Diff.	Standard Deviation: Orig.	Rev.
WHY FOODS SPOIL First Revision																
Grade 5	41	42	50	50	91	92	100.98	101.27	.29	1.69	40.60	42.14	1.54	1.46	10.30	10.05
Grade 7	50	52	44	43	94	95	99.28	99.40	.12	1.61	49.60	51.87	2.27*	1.36	9.03	8.96
Grade 11	53	64	33	39	96	103	71.61	72.69	1.09	1.59	57.48	58.08	.60	1.33	8.46	9.20
WHY FOODS SPOIL Second Revision																
Grades 5-6	32	31	37	39	69	70	105.14	109.27	4.13	1.92	43.51	46.03	3.52*	1.59	9.53	9.21
Grade 8	44	44	41	39	85	83	104.35	107.64	- .71	2.14	53.96	57.49	3.53**	2.60	8.01	9.49
Grades 10-11-12	37	44	32	31	69	75	105.67	104.32	-1.35	2.69	57.93	62.12	4.19**	3.53	7.84	6.25
ATOMS AND MOLECULES																
Grades 5-6	38	40	33	33	71	73	105.25	110.60	5.35*	2.56	28.17	31.78	3.61**	1.52	9.43	8.79
Grade 7	37	37	34	36	71	73	100.21	100.63	.42	1.77	38.35	40.27	1.93	1.40	8.71	8.09
Grade 10	22	24	39	35	61	59	101.97	101.31	- .66	2.15	46.00	46.46	.46	1.69	9.66	8.88

*Significant at .05 level (difference in mean achievement score of grades 5-6 students favoring revised film became non-significant when corrected by covariance for differences in intelligence mean score)

**Significant at .01 level (difference in mean achievement score of 5-6 grade students favoring revised film became non-significant when corrected by covariance for difference in mean intelligence test score)

Following the writing of revised scripts, a research production conference was held with the production director and director of research of the production--Mr. Milan Herzog and Dr. John Bobbitt, respectively. These conferences typically covered two days and, except for follow-up telephone conferences, were virtually the only contact between the researchers and the film producers during the production phase. This constitutes a severe limitation on the study in that, although the producers and investigators maintained the most cordial and cooperative relations, there were inevitably failures of communication. Furthermore, it is quite likely that additional film modifications might have been tested had the investigators been present during the production of the revisions. Considerations of both time and money precluded this, however.

Once revised versions of films were received, showing and testing sessions were held to compare original and revised versions. The general procedure was to locate two classrooms of students at the same grade level. Each class group was divided into two groups of equal numbers by taking alternate names from the teacher's grade book separately for male and female students. The half classes thus obtained were combined to form two groups, and one film version was shown to each group. In most cases, classes were used for which the films had curricular validity; e.g., at the junior high school level, general science classes. By prior agreement, none of the classes had studied the particular subject matter covered by the film in the year that the study was being conducted and none, of course, had seen the films themselves.

The usual procedure for film showing and testing was designed to preserve, insofar as possible, the normal classroom film lesson format without contaminating the results by introducing film discussion between film showing and test administration. The teachers involved were present during the showing and test administration and assisted in passing out materials, maintaining order, etc. The showings were conducted in classrooms or other spaces adapted for the use of motion pictures. Films were introduced stressing their interest value, their relation to the subject taught by the participating teacher, and the fact that test scores would be part of the student's record for grading purposes when appropriate. Since the unusual features of the procedures were obvious, the students were told that they were part of an experiment designed to improve teaching films.

The projector had been set up and prefocused, and the lighting had been properly arranged prior to the arrival of the students. After the introduction, materials were passed out. Then the film was shown. Immediately following, test directions were given and testing began. Students were permitted to take as long as was necessary for all or nearly all to complete the tests. Depending on the grade level, the whole procedure lasted from 60 to 90 minutes.

All tests were machine scored with a procedure that yielded total numbers selecting right responses and members selecting various wrong responses for each student group, and total test score in terms of the number of right responses for each student. The data were analyzed to compare mean scores between versions and to compare proportions selecting various alternatives in each multiple choice item. The results are presented in the next chapter.

TABLE III

NUMBERS OF TEST ITEMS ON WHICH THE PROPORTION OF STUDENTS PASSING FAVORED THE REVISED OR THE ORIGINAL MOTION PICTURE

Film Project	Grade	Total Subjects	Number of Items in Test	Number of Items on which Response Favored Original	Number of Items on which Response Favored Revision
WHY FOODS SPOIL First Revision	5	183	80	16	2
	7	189	80	12	6
	11	199	80	7	4
	1 or more		81	28	12
WHY FOODS SPOIL Second Revision	5-6	139	77	13	3
	8	169	77	10	7
	10-11-12	144	77	19	2
	1 or more		71	30	10
ATOMS AND MOLECULES	5-6	144	68	14	4
	7	144	68	5	2
	10	120	68	5	6
	1 or more		68	17	12

CHAPTER II

RESULTS AND INTERPRETATIONS

The general hypothesis tested in this series of studies was that systematic revisions of an existing motion picture aimed at correcting weaknesses that appeared to explain the relative lack of teaching effectiveness of certain scenes would improve the over-all effectiveness of the film as measured by mean scores on tests of information presented in the film. This hypothesis was supported by the data. Table II shows that the second revision of "Why Foods Spoil" was significantly superior to the original version of the same film in terms of scores earned by pupils at both the elementary and secondary levels. The differences in mean test scores were about eight per cent. First revisions were considerably less successful, however, yielding statistically significant differences in only one out of six comparisons.

Between one-third and one-half of the test items covering information that could have reflected the increased efficiency of revised film versions actually were passed by significantly (.05 level or better) greater proportions of pupils who studied the revised versions. Not every scene was modified in the revisions, of course, but the tests attempted to deal with a representative sample of all of the curricularly valid information presented in the film; therefore, some test items did not bear directly on specific revisions of particular scenes or commentary revisions. Finally, a number of revisions appeared to "backfire;" that is, greater proportions of students who studied the original version passed some test items.

Introductions, Summaries, and Outlines:

Most of the revisions were concerned with individual scenes or short sequences; however, each revision also included modifications intended (1) to strengthen the introduction to the motion picture, (2) to give prominence to the organization of the film, and (3) to improve the summary of the film. The introduction in the revisions of "Why Foods Spoil" substituted a roll title sequence showing the major outline of the film in place of certain scenes that, in the original film version, had shown a pioneer family in their cabin engaging in activities related to obtaining and using food. The same film, in its original version, used music to accompany the beginning of the summary sequence. In the revision, the music

was omitted, and a series of titles over selected scenes from the film summed up the major facts that had been presented.

In revising "Atoms and Molecules," titles were added in the form of a rough outline at the beginning of the revised film, and each of the three major sequences in the film was introduced by a descriptive title. Finally, titles were used in the brief summary or recapitulation at the end. The effects of these endeavors to increase the prominence or obviousness of the organization of the film material should have been manifest in higher total mean scores earned by students who saw the revised version as compared with those who saw the original. Table II shows that while the mean achievement test scores earned by those who saw the revised film version were higher than those earned by the students who saw only the original, the differences were not statistically significant.

Improving the Visibility of That Which Is Intended to Be Seen:

Both experimental films were in color, presumably because certain of the ideas to be portrayed and objects to be shown could best be portrayed and shown in color. Occasionally, however, in "Why Foods Spoil," the original version, the colors of certain objects were not shown with fidelity; for example, scenes in which various molds were shown did not show the range of colors normally displayed by molds. In the revisions, two types of modifications were made which produced significant differences in proportions of students passing related test items: (1) a new short sequence was shot substituting different varieties of molds with strikingly different colors, and (2) the color terms were added to the accompanying commentary.

A related revision referred to what colors were not characteristic of the objects being shown; for example, a cinemicrograph of a yeast had a blue "halo" effect. In the revisions, the commentator was made to say that yeast is not really blue.

In a number of scenes in the original of both motion pictures, there were close-ups of dials, apparatus, and processes in which it appeared that the viewer should be helped to see details more clearly. For example, in "Why Foods Spoil," there was a close-up of a temperature gauge on a milk pasteurizer. In the original, it seemed difficult for the viewer to read the gauge, yet it seemed that for him to do so would help him to remember the temperature at which the pasteurization process takes place. In the

revision, accordingly, this scene was given better definition. Similarly, in the film "Atoms and Molecules," the apparatus for the electrolysis of water was shown, in the original, against a background that did not make it easy to see the relative sizes of the columns of hydrogen and oxygen. In the revision, the background was changed to make it easier to see the entire process.

The Concept of Size:

Both films deal with objects that are too small to fall within the range of normal experience of many children. Both the absolute size and the relative size of molds, yeast, and bacteria were taught in "Why Foods Spoil." In the revision, an attempt was made to relate the sizes of these objects to common objects; for example, an unidentified instrument was shown breaking open a mold sac in the original film, whereas in the revised film, the object was identified as a needle. In addition, the size of each of the three fungi was related, roughly, to the head of a pin.

Attention Directing Devices and Labels:

In a number of scenes the student was required to attend to a single important detail from among many competing details. In such cases an overlay in the form of an arrow was generally included in the revision to indicate the detail to which the student should attend. For example, a scene showing bread mold included arrows to indicate the parts of the mold referred to in the commentary.

Labels were also used in revisions when it did not appear obvious which of two or more objects in a scene was of importance. In "Atoms and Molecules," for example, beakers of colorless liquid were labeled hydrogen peroxide solution and water, respectively, for identification purposes.

Action was also used as an attention directing device. In "Atoms and Molecules," models of water and carbon dioxide molecules were assembled in order to invite attention to their atomic makeup.

Use of Graphics:

Tabular presentation of facts as a summary of information introduced in a number of scenes presented up to that point was tried in "Why Foods

Spoil." The different effects of temperature on plants--extremes being associated with inhibiting growth--were summarized in a chart. Also, a revision of the same film incorporated a chart to give a general idea of the sizes of molds, yeasts, and bacteria.

Showing in the Video What the Audio Refers to:

In a few instances, the commentary referred to objects that could have been shown in the video, but were not. An example is that, in referring to the forms of carbon, the commentary in "Atoms and Molecules" included all the major forms, but the video did not. In the revision, the scene included coal, graphite, and diamonds. In the same film, a closer agreement between audio and video was achieved between successive scenes. One passage showed a cube measuring a mile in each dimension, while the commentary said that this was the amount of sand that would result if the molecules in a single grain became as large as the grain itself. The following scene used a model of a sugar molecule to show that some molecules are made of larger numbers of atoms. In the revision, the previous mention of sand was carried further by using a molecule of one of the constituents of sand for this purpose. Similarly, in the same film, there is a scene in which a page of a dictionary is shown as the commentary points out that just as letters are the "building blocks" from which a great many words can be made, elements are the "building blocks" from which a great many compounds may be made. The next scene, carrying out the analogy, begins a series on the periodic table. In the original, no thought had apparently been given as to what page of the dictionary to show. In the revision, the close-up scene showing a finger locating a word on a page of the dictionary had the finger stop on "periodic table."

As a further example, in the original of "Atoms and Molecules," the electrolysis of water was shown. It was implied, of course, that a process using electricity was being shown. In the revision, batteries were shown being attached to the electrolysis apparatus. In the same sequence, the identification of the water, the hydrogen, and the oxygen (all colorless), which was made in the case of the original film by the commentary, was assisted in the revision by arrows in addition to labels.

A somewhat different use of a somewhat different kind of identification was employed in revising "Why Foods Spoil." Two children are shown

working in a kitchen as part of a sequence on showing how molds may start on moist bread that has merely been exposed to the air. In the revision, the children were given names by the commentary.

Visual Verbosity:

In several sequences in both motion pictures, a number of examples of a certain class of objects were shown. In revising these sections, a somewhat more complete range of objects was included. For example, in "Why Foods Spoil," the film makes the point that various kinds of cheeses derive their distinctive flavors from the different varieties of molds used in cheese making. This message is carried in the audio. In the revision, the number of kinds of cheeses displayed in the video was increased. In the same motion picture, packages of cottage cheese and butter were added to a display to reinforce the idea of the usefulness of some bacteria. In "Atoms and Molecules," the revised introduction showed a greater number of substances to illustrate the great variety of materials and matter that exist in the natural state.

Changes in Structure in Commentary:

To provide greater emphasis on what appeared to be the more crucial parts of the message, the sequences of ideas in the commentary were changed in a number of instances. For example, in "Why Foods Spoil," a commentary passage was modified as follows:

original: "Like mold, some yeasts are..."

revision: "Some yeasts, like some molds..."

The passage thus modified was in a sequence dealing with yeasts; therefore, the primary position was given to the word "yeast." Similarly, the original version of one passage began with a series of phrases such as "When foods spoil, when milk gets sour, etc.," and concludes with the statement that bacteria are the cause. In the revision, the words "cause" and "bacteria" were moved up to the beginning of the passage.

It was hypothesized that to have the important object do something rather than to have something done to it would be an improvement. This kind of commentary change is illustrated by the following revision of the film "Why Foods Spoil":

original: "...by watching some food spoil..."

revision: "...by watching them spoil some food..."

The foregoing was a passage in which the aim of the film was to show that molds often spoil food. In the same sequence, the original commentary passage included, "...the bread should be placed in...," and in the revision the passage was altered to read, "...put the bread in..."

Again, a passage reading, "...special flavors in cheeses are sometimes caused by molds...," to the following: "...these different kinds of cheeses get their distinctive flavors from molds."

Finally, note the change in emphasis in the original and revised commentary passages that follow:

original: "See the dust rise and float away in the air as we brush it. This dust is made up of thousands of tiny spores that have been growing there."

revision: "See the thousands of tiny spores that rise and float about in the air like dust. A new mold plant can grow from each tiny spore."

In this modification, the attempt was to put the emphasis on the mold spores and how they float in the air, rather than to emphasize their similarity to dust. It was also possible, in the same footage, to reinforce the information that spores act like seeds in spreading new mold.

Verbal Penuriousness:

If fewer words are used in the commentary, but the essence of the meaning is retained, it may be that greater attention can be released to the video portion of the film, and that each key word of the commentary may receive greater emphasis and attention. For example, in "Why Foods Spoil" one passage read, "...there is a sack full of mold seeds. We tall these seeds spores." In the revision the passage became, "...there is a sack of mold seeds called spores."

Later, in the same motion picture, a passage was reduced in word count by about twenty-five per cent as follows:

original: "A lot of foods are preserved by killing molds, yeasts, and bacteria with heat.... Canning is one of the best ways to keep food from spoiling. The food is placed in jars or cans and cooked. Then it is sealed so that more yeasts, molds, and bacteria can not enter. The heat, like that of boiling water, kills the tiny plants that would make foods

spoil. Heat, plus the sealing, will preserve the food for many months."

revision: "Canning is a way of preserving food by using heat. The food is placed in jars or cans; then cooked. The jars of food are heated in boiling water to kill the tiny plants that would make the food spoil. When the heat has killed the mold, yeast, and bacteria, the jars are sealed to keep out other plants.

Commentary time gained by revisions such as the foregoing was sometimes used for adding commentary for such purposes as emphasizing the relationship between the scene presently being shown and a previous scene. Such phrases as, "Once again, just as with molds and yeasts..." or, "Remember, we moistened the bread..." or, "Similar to what we have previously seen..."

Direct Statement in Commentary Versus Student Inference:

One of the major points in "Why Foods Spoil" was that molds, yeasts, and bacteria have been even made to serve useful purposes as well as being, on occasion, destructive. It was anticipated that frequent direct statements of this fact in different contexts would reinforce the idea in the minds of the students. Thus, a passage in the original version of "Why Foods Spoil" which read, "...some foods keep longer when dried in the sun," was changed in the revised version to read, "...take away moisture and the food will be preserved." This passage was associated in both versions with a sequence that showed that a pea seed will germinate and grow in moist soil, but will remain dormant in dry soil. A similar example is found in the addition of the phrase, "Some molds are beneficial to foods. For example..." to the basic commentary passage in the original film in which the use of mold to produce flavors in cheese was noted. Generally, these direct statements were made to appear early in the commentary passage and were followed by supporting statements.

A similar type of revision in the commentary is illustrated by the following:

original: "Heat, like that of boiling water, kills..."

revision: "Canning preserves food by using heat."

And, similarly:

original: "...special light rays are used to..."

revision: "Special light rays, like concentrated sunlight, kill..."

The latter of the foregoing two revisions was in the context of preserving food by exposing it to sunlight, and, by reverse analogy, encouraging mold growth by putting moistened bread in a dark place.

Precision Phrasing:

When possible, revisions in commentary passages were made by employing words having more precise meaning or by making specific statements rather than general ones. For example, in referring to a plant in an "experiment" shown in "Why Foods Spoil," the oiginal commentary described the plant as "doing well," and the revision described it as "growing well," since plant growth had been identified with the effects of fungi on food. Similarly, "at low temperature" in the original became "30 degrees below zero" in the revision; "almost indefinitely" became "for months or even years"; and "heated to a temperature which kills" became "heated to 100 degrees to kill."

APPENDIX A

A.

FILM CONTINUITY
FOR THE ORIGINAL FILM
WHY FOODS SPOIL

1. Pioneer family around fireplace; father comes in with meat--
24' (Music out)
NARRATOR: A long, long time ago people spent much time

2. Father puts meat on hearth -- 28'
in search of food. When a hunter killed a large animal,
there was usually more than enough to eat.

3. Family eating dinner -- 34'
So the family ate and ate heartily. They knew that what they
could not eat would soon spoil and go to waste.

4. Father and girl eating -- 36'

5. Mother gets up from table -- 37'
The hunter's wife must have wished she knew how to keep

6. Mother stirs cherries in pot -- 40'
all this food from spoiling. But there were only a few ways

7. CU cherries being stirred -- 43'
to keep food from going bad in those days. American pioneers,
of course, knew how to preserve

8. PAN corn, peppers and onions hanging from ceiling -- 50'
some foods and they learned from the Indians how to keep
others. Sometimes new ways of keeping foods were found
accidently. The news of this would spread

9. Mother comes out of house carrying jar -- 58'
from neighbor to neighbor. For instance people discovered
that foods keep longer in cool places so they stored food in
cellars underground that would stay cool even in the summer.

10. Mother puts jar with others in cellar -- 63'
But only recently have we discovered why foods spoil.

11. People at meat counter -- 69'
Now we can buy food weeks or even months before we will
actually eat it. Food can be sent across the country and
kept in grocery stores

12. Woman buying meat -- 73'
and supermarkets for a long time, with no fear of the food spoiling.

13. Woman comes in kitchen with groceries -- 78'
Today, we know that keeping food fit to eat means keeping three different kinds of tiny plants out of the food.

14. Woman and children start putting groceries away -- 83'
These tiny plants are called: molds, yeasts, and bacteria.

15. CU children -- 90'
Remember the words: molds, yeasts, and bacteria.

16. Girl puts slice of bread on saucer -- 94'
First, let's learn about molds by watching some food spoil --a slice of bread, for instance.

17. CU children -- 95'

18. CU bread being moistened -- 102'
The slice of bread should be moist. Tiny mold seeds floating in the air will fall on the bread. Then the bread should be placed

19. Boy puts bread in cupboard -- 104'
in a dark, warm place for about two days.

20. Mold on bread -- 111'
Do you see the fuzz that has grown on the bread? It is called bread mold. Moldy bread doesn't taste good. Let's look at this bread mold through a magnifying

21. Photomicrography of bread mold -- 117'
glass. Mold is a tiny plant. That fuzz on the bread is a small garden of mold plants. And the bread itself is the garden

22. Photomicrography of mold plants -- 125'
plot. The mold seeds were planted when they fell on the bread from the air. Notice that the bread mold has many little branches and roots. We can see that the roots

23. ECU mold plant -- 133'
of the mold grow deep into the bread, just as roots of plants grow deep into the soil. Do you see the dark cluster at the top of the mold plant on the left?

24. ECU mold plant with seeds -- 136'
With a stronger lens we can see that this round dark cluster

25. FAN mold plants, spores are knocked off -- 143'
is a sack, full of mold seeds. We call these mold spores. Spores are so light that they float in the air and so they can easily get into our food.

26. Spores are brushed off moldy bread -- 154'
If you take a brush and brush away the mold on bread, you will see dust rise. This dust is made up of the thousands of tiny spores that have grown on a single slice of bread. Most molds spoil food, but some molds can be put to work for us.

27. Several kinds of cheese -- 163'
Certain molds give cheese a special flavor, and so some kinds of cheese we have, we owe to the different kinds of molds. But when molds grow on the wrong foods, they spoil the taste and may destroy some of the food value.

28. Scientist in laboratory -- 166'
With a microscope, scientists study different kinds of mold, and separate

29. CU placing dish under microscope -- 171'
those that are useful from those that are not. Different molds have different colors and shapes. There are many kinds of molds,

30. ECU dish of mold -- 175'
just as there are many varieties of plants and flowers in a garden.

31. CU another kind of mold -- 179'
Each mold acts on a different kind of food in a different way.

32. CU another kind of mold -- 181'

33. Hands cover dishes of molds -- 187'
It is usually easy to discover food that has become moldy because the mold plants grow on the surface where we can see them. But some tiny plants that spoil

34. Girl pouring orange juice -- 190'
food are almost invisible. This orange juice, for example,

35. CU orange juice -- 193'
is being spoiled by another kind of tiny plant called yeast.

36. CU orange juice, bubbles rising -- 195'
See those bubbles coming up through the orange pulp in the bottom of the glass? They tell us that yeast plants are growing in the food.

37. Photography of yeast -- 203'
Yeasts are too small to be seen even with an ordinary magnifying glass. But we can see them through a microscope.

38. Orange juice, bubbles rising -- 212'
These bubbles are a gas, carbon dioxide, which yeasts give off when they feed on sugar and water. As the yeasts grow and multiply, they make the juice turn sour.

39. Woman kneading bread dough -- 215'
Like molds, some yeasts are very useful.

40. CU kneading; dough is put in bread pan -- 225'
For instance, some yeasts make bread dough rise. Mother deliberately put a special kind of yeast in the flour she uses to bake bread. As this yeast grows, it too will give off carbon dioxide and this gas

41. CU covered bread pan, see raised dough -- 229'
is what makes bread dough rise.

42. Cutting bread -- 233'
Now we can see the airholes in the bread which have been made by the gas escaping

43. CU bread -- 238'
from the yeast. So it is yeasts which make bread fluffy and light.

44. Scientist in laboratory, makes slide -- 247'
The third kind of plant that spoils food is called bacteria. Bacteria are the smallest of all plants. They can be seen only with the aid of a strong

45. CU slide is placed under microscope -- 250'
microscope. Bacteria can be divided into three groups.

46. Round bacteria -- 255'
These pictures show one bacteria from each group. One kind of bacteria is round,

47. Rod bacteria slide -- 258'
another kind is shaped like a number of little sticks or rods,

48. Chain bacteria -- 263'
the third kind is formed into little chains one connected with the other.

49. Hand shows bacteria culture, brings in half dollar -- 270'
It is difficult to imagine how small bacteria are. If all the people in the world were turned into bacteria, they would hardly cover this half dollar coin.

50. Spoiled foods -- 281'
When meat and vegetables spoil and are no longer good for us to eat; when milk turns sour, bacteria are the cause. Once again, just as with molds and yeasts, some bacteria are useful. But because many bacteria are dangerous to our health,

51. Scientist in laboratory -- 284'
scientists study them. An easy way to grow bacteria

52. Fingers pressed on culture -- 288'
is to press your fingers on this special jelly. There are sure to be bacteria on your fingers. Now cover the dish

53. Scientist puts dish in cupboard -- 293'
and put it in a warm, dark place for two days.

54. Bacteria culture -- 298'
See where the fingers touched the jelly? Millions of bacteria are growing there. They grow in a similar way on food

55. Scientist washes hands -- 315'
    and many make it poisonous. There are bacteria almost everywhere. We should wash our hands often with soap and water to get rid of as many bacteria as possible. Otherwise some of the harmful ones may be carried into our body and cause disease. We have seen that three kinds of tiny plants may grow on foods and spoil them. Molds, yeasts and bacteria. Let's learn how to keep these tiny plants from spoiling food.

56. Drying fish -- 321'
    One of the oldest ways of preserving food is drying it. Long ago, people noticed that some foods keep longer when dried in the sun.

57. Eskimo checking drying fish -- 324'
    Fishermen in many parts of the world dry fish in the sun.

58. Drying fish -- 328'
    The drier the fish, the longer it will keep. Some fish are dried and salted.

59. Men salting fish -- 331'
    The salt helps take the water out of the fish and keep it dry.

60. Hams in smokehouse -- 336'
    Many kinds of meat keep longer when preserved with smoke. Let's explain why drying foods helps preserve them.

61. Two pea seeds, one in wet soil, one in dry -- 344'
    To do this, we'll try an experiment. Here are some pea seeds. The one on the left has been planted on dry soil; the one on the right has been watered.

62. Seed in wet soil growing -- 350'
    The seed in the container with the moist soil is doing well. But the seed in the dry soil isn't growing at all.

63. Leaves come -- 354'
    This experiment shows that a plant, even a tiny plant that spoils food needs water to grow.

64. Two pea plants in pots -- 357'
    One more experiment. These are two

65. Plant placed in ice, one on burner -- 363'
healthy young pea plants. We'll cool the plant on the right and heat the plant on the left.

66. Heated plant wilts -- 368'
See how the plant on the left begins to wilt after the heat is turned on.

67. Wilted plant and dormant plant -- 377'
And the cooled plant stops growing. We all know that plants don't grow in cold winter weather. Molds, yeasts, and bacteria are plants too. Here are the clues to two more ways of preserving foods,

68. Girl opens refrigerator, to put milk away -- 384'
by heat and by cold. Food keeps in refrigerators because tiny plants either do not grow or grow so slowly that it will take a long time before the food spoils.

69. CU inside freezer -- 394'
Very low temperatures like those in a freezer kill some of the tiny plants and slow down the growth of others. It would take months, possibly years, to spoil food kept in a deep freeze of your home or in store freezers.

70. Woman canning tomatoes, girl helping -- 398'
A lot of foods are preserved by killing molds, yeasts and bacteria with heat.

71 Woman puts jars into pot -- 406'
Canning is one of the best ways to keep food from spoiling. The food is placed in jars or cans and cooked. Then it is sealed so that new molds,

72. CU putting lid on pot -- 408'
yeasts and bacteria cannot enter.

73. Woman opens pot -- 413'
The heat kills the tiny plants that would make the food spoil. In this way food will keep for many months without spoiling.

74. Woman looking at jars of canned tomatoes -- 417'
Today, many people work in plants which preserve food by heating, drying and freezing.

75. Man pours milk in pasteurizer -- 423'
Almost all the milk we drink is quickly heated to a temperature which kills any dangerous bacteria in milk. We call this pasteurized milk. The people who pasteurize milk

76. CU thermometer on pasteurizer -- 427'
must be very careful to keep the milk exactly the right temperature.

77. Canning machine -- 429'
Many of the foods we eat today are cooked

78. Another view of canning machine -- 434'
and sealed tightly in cans at large canneries such as this one.

79. Filled cans coming out of machine -- 437'
Food in cans will keep almost indefinitely.

80. Tray of meat put in freezer -- 441'
Quick freezing is one of the newer ways of keeping foods; meat, fruit, vegetables, even baked and cooked foods stay fit to eat for a long time when kept in a deep freeze

81 CU thermometer on freezer -- 446'
at very low temperatures.

82. Jar of eggs -- 448'
This jar contains eggs.

83. Dehydrator -- 451'
Eggs are dried so thoroughly in this machine that they turn into powder.

84. Egg powder -- 457'
As long as they are kept dry no tiny plants can grow in them. Many foods can be dried into powder form.

85. Meat going under light ray -- 462'
Here special light rays are used to destroy the plants that spoil food.

86. CU orange juice -- 467' (music in)
In this film we have seen that molds, yeasts, and bacteria are plants that cause food to spoil.

87. CU mold plants -- 469'
We have learned that these plants need food,

88. ECU mold plants -- 470'
moisture and air to live.

89. Eskimo checking drying fish -- 474'
We have learned how to dry foods so that these tiny plants cannot grow in them.

90. Girl opening refrigerator to put milk away -- 479'
We have seen that low temperatures will kill most tiny plants. We have also discovered how to destroy molds,

91. Woman looking at canned tomatoes -- 485'
yeasts, and bacteria by heating foods. These are some of the ways to preserve foods. There are many others. We will have more

92. Scientist in laboratory -- 490'
and better food as scientists find new ways to keep foods from spoiling.

END TITLE -- 494' (Music out)

APPENDIX B

WHY FOODS SPOIL
THE FR REVISED FILM CONTINUITY
(First Revision)

EB FORCUS TITLE

MAIN TITLE

CREDIT TITLE

1. Cave man with food.
   A long time ago people spent much time in search of food.

2. Cave man and family eating.
   What they obtained had to be eaten promptly for they knew that what they could not eat would soon spoil and go to waste.

3. Mother stirs cherries in pot.
   American pioneers, of course, knew how to preserve...

4. Pan corn, peppers, and onions hanging from ceiling.
   some foods and they learned from the Indians how to keep others. Sometimes new ways of keeping foods were found accidentally.

5. Mother comes out of house carrying jar.
   For instance, people discovered that foods kept longer in cool places so they stored food in cellars underground that would stay cool even in the summers.

6. Mother puts jar with others in cellar.
   But only recently have we discovered why foods spoil.

7. People at meat counter.
   Now we can buy food weeks and even months before we will actually eat it. Food can be sent across the country and kept in grocery stores ...

8. Woman buying meat.
   and supermarkets for a long time, with no fear of the food spoiling.

9. Roll Title
   Several ideas will be presented in this film. Watch for them.

You will learn about
Molds
Yeasts
Bacteria

and how they
Grow
Improve the taste of food
Cause foods to spoil

Foods spoil when they are
Kept warm
Kept damp
Exposed to molds, yeasts, and bacteria.

You will see how and why foods are preserved by
Drying
Heating
Freezing
Cooling.

Notice the differences in mold, yeasts, and bacteria in
Shapes
Sizes
Colors.

10. Woman comes in kitchen with groceries.
Today we know that keeping food fit to eat means keeping three different kinds of tiny plants out of the food.

11. Woman and children start putting groceries away.
These tiny plants are called: molds, yeasts, and bacteria.

12. CU children
Remember the words: molds, yeasts, and bacteria.

13. Girl puts slice of bread on saucer -- OVERLAY TITLE
First, let's learn about molds by watching them spoil some food -- a slice of bread, for instance.

14. CU children.

15. CU bread being moistened -- spores in air.
Susan sprinkles on water because molds grow best on moist foods. There are mold seeds floating in the air. Some fall on the bread. John puts the

16. Boy puts bread in cupboard.
bread in a dark, warm place for about two days.

17. Boy closes cupboard door.
Certain kinds of plants need darkness to grow -- mold is one.

18. Mold on bread.
Do you see the fuzz that has grown on the bread? It is called bread mold. Moldy bread doesn't taste good. Let's look at this bread mold through a magnifying...

19. Photomicrography of bread mold.
glass. Mold is a tiny plant that on bread is seen as green. That fuzz on the bread is a small garden of mold plants...

20. Photomicrography of mold plants. Arrows point out branches and roots.
they grew when they fell on the bread from the air. Notice that the bread mold has many little branches and roots. We can see that the roots...

21. ECU mold plants.
of the mold grow deep into the bread, just as the roots of plants grow deep into the soil. Do you see the dark cluster at the top of the mold plant on the left?

22. ECU mold plant with seeds.
With a stronger lens we can see that this round dark cluster...

23. Pan mold plants, spores are knocked off with needle.
is a sack full of mold seeds called spores. Spores are very tiny. Compare their size with the needle point here used to break the sack.

24. Spores brushed off moldy bread.
Our moldy slice of bread has been dried. See the dust rise and float away in the air as we brush it. This dust is made up of thousands of tiny spores that have been growing there.

25. Several kinds of cheeses.
Molds are sometimes beneficial to foods. For instance, special flavors in cheeses are sometimes caused by

molds. But when molds grow on the wrong foods, they spoil the taste and may destroy some of the food value.

26. Scientist in laboratory.
With a microscope, scientists study different kinds of mold, and separate...

27. CU placing dish under microscope.
those that are useful from those that are not. Different molds have different color and shapes which cannot always be shown accurately in this film.

28. ECU dish of mold.
Here are three of the many kinds of molds but all are related to the common bread mold.

29. CU another kind of mold.
Some of them can also be found on jellies and fruit.

30. CU another kind of mold.
Each mold acts on a different kind of food in a different way.

31. Hands cover dish of molds.
It is usually easy to tell when foods have become moldy because the mold plants usually grow on the surface where we can see them. But some tiny plants that spoil...

32. Girl pouring juice.
food are almost invisible. This orange juice, for example...

33. CU orange juice -- OVERLAY TITLE
is being spoiled by another tiny plant called yeast.

34. ECU orange juice, bubbles rising.
See those bubbles coming up through the orange pulp in the bottom of the glass? They tell us that yeast plants are growing in the food.

35. Photomicrography of yeast.
To see yeasts, we must use a microscope. Yeasts are not really blue but these have been stained to help us see them.

36. Orange juice, bubbles rising.
    These bubbles are a gas, carbon dioxide, which yeasts give off when they feed on sugar and water. As the yeasts grow and multiply, they spoil the juice.

37. Woman kneading bread dough.
    Some yeasts, like some molds, are very useful.

38. CU kneading; dough is put in bread pan. (OVERLAY TITLE -- NO CARBON DIOXIDE)
    This bread dough has yeasts in it. As in the juice the yeast will give off carbon dioxide as it grows.

39. CU covered pan with raised dough. (OVERLAY TITLE-- PLUS CARBON DIOXIDE)
    See how, after a few hours, the carbon dioxide has puffed up the dough.

40. Cutting bread.
    Now we can see air holes in the bread which have been made by the gas escaping...

41. CU bread.
    from the yeast. So it is yeasts which make breads fluffy and light.

42. Scientist in laboratory, makes slide -- OVERLAY TITLE
    Bacteria are smaller than yeasts or molds. This scientist is putting bacteria on a microscope slide. He colors them with a stain to help us see them. They are not really pink.

43. CU slide is placed under microscope.
    Bacteria can be divided into three groups.

44. Round bacteria. (OVERLAY TITLE -- BALL)
    These pictures show one bacteria from each group. One kind of bacteria is ball or round shaped.

45. Rod bacteria slide (OVERLAY TITLE -- ROD)
    Another kind is shaped like a number of little sticks or rods.

46. Chain bacteria (OVERLAY TITLE -- SPIRAL)
    The third kind is formed into spirals or chain-like forms, one connected with the other.

47. Hand shows bacteria culture, brings in half dollar.
    It is difficult to imagine how small bacteria are. If all the people in the world were turned into bacteria, they would hardly cover this half dollar coin.

48. Spoiled foods.
    Bacteria are the cause of meats, vegetables, and milk spoiling.so that they are no longer good for us to eat. Once again, just as with molds and yeasts...

49. CU container of cottage cheese.
    some bacteria are useful. Bacteria are used in making cottage cheese and butter. But because many bacteria are dangerous to our health...

50. Scientist in laboratory.
    scientists study them. An easy way to grow bacteria

51. Fingers pressed on culture.
    Is to press your fingers on this special jelly. There are sure to be bacteria on your fingers. Now cover the dish...

52. Scientist puts dish in cupboard.
    and put it in a warm, dark place for two days.

53. Bacteria culture.
    See where the fingers touched the jelly? Millions of bacteria are growing there. They grow in a similar way on food...

54. Scientist washes hands.
    and many make it poisonous. There are bacteria almost everywhere. We should wash our hands often with soap and water to get rid of as many bacteria as possible. Otherwise some of the harmful ones may be carried into our body and cause disease. We have seen that three kinds of tiny plants may grow on foods and spoil them. Molds, yeasts, and bacteria. Let's learn how to keep these tiny plants from spoiling food.

55. Drying fish.
    One of the oldest ways of preserving food is drying it. Remember we moistened bread so mold would grow; take away moisture, and food will be preserved.

56. Eskimo checking drying fish.
    Fishermen in many parts of the world dry fish in the sun.

57. Drying fish.
    The drier the fish, the longer it will keep. Some fish are dried and salted.

58. Man salting fish.
    The salt helps take the water out of the fish and keep it dry.

59. Hams in smokehouse.
    Many kinds of meat, such as these hams in a smokehouse, keep longer when dried with smoke. Let's explain why drying foods helps preserve them.

60. Two pea seeds, one in wet soil, one in dry.
    To do this, we'll try an experiment similar to the one we have seen with mold and bread. Here are some pea seeds. The seed on the left has been planted in dry soil; the seed on the right has been watered.

61. Seed in wet soil growing.
    The seed in the container with the moist soil is growing well. But the seed in the dry soil isn't growing at all.

62. Leaves come.
    This experiment shows a plant that needs moisture to grow. Even tiny plants that spoil food need moisture.

63. Two pea plants in pots.
    One more experiment. These are two...

64. Plant placed in ice, one on burner.
    healthy young pea plants. We'll cool the plant on the right and heat the plant on the left.

65. Heated plant wilts.
See how theplant on the left begins to wilt after the heat is turned on.

66. Wilted plant and dormant plant.
And the cooled plant stops growing. We all know that plants don't grow in cold winter weather. Molds, yeasts, and bacteria are plants too. Here are the clues to two more ways of preserving foods...

67. Girl opens refrigerator to put milk away.
by heat and by cold. Food keeps in refrigerators because tiny plants either do not grow or grow so slowly that it will take a long time before the food spoils.

68. CU inside freezer.
Food keeps in freezers because it is so cold that tiny plants stop growing or grow so slowly that it would take months, possibly years, to spoil food kept in a deep freeze of your home or in store freezers.

69. Woman canning tomatoes, girl helping.
A lot of foods are preserved by killing molds, yeasts, and bacteria with heat.

70. Woman puts jars in pot.
Canning is one of the best ways to keep food from spoiling. The food is placed in jars or cans and cooked. Then it is sealed so that more yeasts, mold, and bacteria...

71. CU putting lid on pot.
cannot enter.

72. Woman opens pot.
The heat, like that of boiling water, kills the tiny plants that would make the food spoil. Heat plus the sealing will preserve the food for many months.

73. Canning machine.
Many of the foods we eat today are cooked...

74. Another view of canning machine.
and sealed tightly in cans at large canneries such as this one.

75. Filled cans coming out of machine.
Food in cans will keep for months and often for years.

76. Man pours milk in pasteurizer.
The milk we drink is usually pasteurized. Pasteurized milk is heated to 160° to kill most of the bacteria that would spoil it or cause sickness.

77. CU thermometer on pasteurizer -- ARROW POINTS TO TEMPERATURE READING.
The people who pasteurize milk must be very careful to keep the milk exactly the right temperature.

78. Tray of meat put in freezer.
Quick freezing is one of the newer ways of keeping foods. Many kinds of foods stay fit to eat for a long time when kept in a deep freeze...

79. CU thermometer on freezer.
at low temperatures of about 30 degrees below zero.

80. Jar of eggs.
This jar contains eggs.

81 Dehydrator.
Eggs are dried so thoroughly in this machine that they turn into powder.

82. Egg powder.
As long as they are kept dry no tiny plants can grow in them. Many foods can be dried into powder form.

83. Meat going under light ray.
We know that molds, yeasts, and bacteria grow best in darkness; that is, when protected from sunlight. Here special lights, like concentrated sunlight, quickly kill the plants that spoil food.

84. Roll Title.
A few of the ideas you have seen are more difficult to understand than others. Think about these points:

Molds, yeasts, and bacteria have some things in common. They grow best in warm, dark, moist places.

Cold, heat, dryness, and light can slow down or kill the growth of these three plants.

They do differ in size and shape, both among themselves and from each other. Some of them are harmful and some are helpful to man.

Molds aren't always green and they can be of many different shapes. Mold spores float in the air around us.

Yeast gives off carbon dioxide which can improve foods or spoil foods.

Bacteria are the smallest of the three plants, and, like yeast, can only be seen through a microscope.

85. Diagram illustrating differences in sizes of molds, yeasts, and bacteria.
The molds, yeasts, and bacteria seen in this film can be compared in size on this chart. To cover a straight line across the head of an average size pin, it would take 2 mold plants, 475 yeast plants, or 1,750 bacteria.

86. Drying food. (OVERLAY TITLE -- DRYING)
Man has used this knowledge in preserving food by drying...

87. Canning food (OVERLAY TITLE -- CANNING)
canning...

88. Freezing food. (OVERLAY TITLE -- FREEZING)
freezing...

89. Cooking food. (OVERLAY TITLE -- COOKING)
cooking...

90. Irradiating food. (OVERLAY TITLE -- LIGHT)
and light.

END TITLE

TEST

WHY FOODS SPOIL

1. In pioneer America, meat killed in warm weather could be preserved:

   1. for several days
   2. for several weeks
   3. for several months
   4. could not be preserved

   (II 1 same -- IV 1 same)

2. Pioneers knew how to preserve food by:

   1. canning
   2. salting
   3. pasteurizing
   4. drying

   (II 2 same -- IV 30 same)

3. In the pioneer's cellar were jugs and crocks containing food that was:

   1. frozen and cooked
   2. smoked and cooled
   3. smoked
   4. cooled

   (II 3 same -- IV 2 same)

4. The early Americans learned to preserve food by:

   1. accident
   2. learning from the Indians
   3. reading about it in books
   4. both 1 and 2

   (II 4 same -- IV 3 same)

5. When the girl was moistening the bread to make a mold garden, where did the mold come from that grew on the garden:

   1. her hands
   2. the air
   3. the water
   4. the bread

   (II 5 same -- IV 31 same)

6. In order to allow mold to grow, the bread had to be:

   1. warm and moist
   2. dark and cold
   3. warm and dry
   4. moist and cold

   (II 6 same -- IV 32 same)

7. Which more accurately describes the color of mold:

   1. brownish
   2. greenish
   3. whitish
   4. any of these

   (II 7 same -- IV 33 same except "4. can be all of these")

8. Mold is a tiny:

   1. bacteria
   2. plant
   3. yeast
   4. animal

   (II 8 same -- IV 4 same)

9. If mold is planted on Monday, it will grow enough to be seen by:

   1. Monday
   2. Tuesday
   3. Wednesday
   4. Saturday

   (II 9 same -- IV 5 same)

10. The fuzz on the bread was called:

    1. bread mold
    2. flour mold
    3. garden mold
    4. yeast mold

    (II 10 same -- IV 6 same)

11. Which is correct:

    1. molds are bigger than yeasts
    2. yeasts are bigger than molds
    3. yeasts are smaller than bacteria
    4. bacteria are bigger than molds

    (II 11 same -- IV 54 same)

12. Which one is greenish in color:

    1. yeast
    2. bacteria
    3. molds
    4. fungus

    (II 12-same IV-55 same except "when seen on the bread" was added after the word "color" in the stem)

13. Which is correct:

    1. molds have both branches and roots
    2. molds have roots only
    3. molds have branches only
    4. yeasts have both branches and roots

    (II 13 same -- IV 7 same)

14. Spores are found in:

    1. molds, yeasts and bacteria
    2. molds and yeast
    3. molds only
    4. yeasts only

    (II 14 same -- IV 8 same)

15. When a person sneezes, he is "releasing":

    1. yeasts
    2. molds
    3. bacteria
    4. all of these at the same time

    (II 15 same -- IV 56 same)

16. Which is a mold:

    1. 2. 3. 4.

    (II 16 same -- IV 57 same)

17. Molds are closer in size to a:

    1. pencil eraser
    2. baseball
    3. pencil point
    4. marble

    (II 17 same except "3. pinhead" -- IV 58 same)

18. One <u>sack</u> produces:

    1. one pair of spores
    2. one pair of buds
    3. thousands of spores
    4. thousands of buds

    (II 18 same -- IV 9 same)

19. Which can be seen with the naked eye:

    1. bacteria
    2. yeasts
    3. molds
    4. none of these

    (II 19 same -- IV 10 same)

20. The part marked with the arrow is about as large as a:

1. golfball
2. baseball
3. marble
4. pencil point

(II 20 same except "4. pinhead" -- IV 59 same)

21. Which do you think is closest in size to the thing used to break open the sack:

1. pencil
2. toothpick
3. needle
4. finger

(II 21 same except the stem was changed to: "What do you think was used to break open the sack:" -- IV 11 same)

22. A mold seed is also called a mold:

1. sack
2. bud
3. spore
4. bag

(II 22 same -- IV 12 same)

23. The mold on the bread was being loosened with a brush to show that:

1. it was lighter than air
2. it was just dust
3. mold is planted from the air
4. *a brush is needed to make mold grow*

(II 23 same -- IV 13 same except "3. mold seed can float in the air")

24. Mold can cause:

    1. cheese to have different flavors
    2. cheese to preserve itself
    3. milk to be made into cheese
    4. milk to become sour

    (II 24 same -- IV 14 same)

25. For a scientist to examine mold to learn if it is helpful or harmful, it must be:

    1. placed on a glass slide
    2. dyed so it can be seen
    3. passed through a flame
    4. none of these

    (II 25 same except the changed from: "In order for a scientist to examine it, mold must be:" and "2. placed in a test tube" -- IV 17 was changed to: "In order to learn if mold is helpful or harmful, a scientist must examine the mold with a: 1. magnifying glass, 2. glass slide, 3. mirror, 4. microscope")

26. Molds growing on some foods can:

    1. spoil the taste of the food
    2. improve the food value
    3. preserve the food
    4. protect the food from "drying out"

    (II 26 same -- IV 15 same except the word "bond" in the stem was changed from the word "different" and "4. both 1 and 2")

27. Molds of cheese can grow:

    1. on the surface
    2. in the middle
    3. on the bottom
    4. both 1 and 2

    (II 27 same -- IV 16 same except "1. on the surface of cheese, 2. in the middle of cheese, 3. can't grow on cheese")

33. The bubbles coming up through the orange juice show that:

1. the juice is carbonated
2. the juice is being perserved
3. the juice is sour
4. the juice is evaporating

(II 33 same -- IV 22 same except "1. the juice is producing spores" and "3. the juice is sour and spoiled")

34. When yeasts feed on sugar and water, they give off:

1. hydrogen
2. oxygen
3. carbon dioxide
4. all of these at the same time

(II 34 same -- IV 23 same)

35. Where would bread dough rise fastest:

1. in the refrigerator
2. in a warm place
3. in a freezer
4. in a cool cellar

(II 35 same -- IV 61 same)

36. Bread dough rises because of the:

1. action of bacteria
2. action of yeast
3. combination action of yeast and bacteria
4. action of mold on sugar

(II 36 same -- IV 24 same)

37. Gas being released by yeast:

1. makes holes in cheese
2. makes holds in bread
3. makes bubbles in juice
4. 2 and 3 only

(II 37 same -- IV 62 same)

39. Yeasts are:

1. blue
2. green
3. colorless
4. the film didn't say what color yeasts really are

(II 38 same except "4. the film didn't say" -- IV 23 same)

39. The bread dough was placed in a large pan because it would expand from:

1. yeast and bacteria combination
2. yeast and warmth combination
3. flour and warmth combination
4. sugar and water combination

(II 39 same -- IV 63 same)

40. Which is not a bacteria:

1. 2. 3. 4.

(II 40 same -- IV 64 same)

41. What color are bacteria:

1. green
2. grey
3. purple
4. the film didn't say what color bacteria really are

(II 41 same except "4. the film didn't show this" -- IV 33 same

42. Allow 100 bacteria for every 100 persons in the world and you could put all the bacteria on one side of a:

1. penny
2. dime
3. quarter
4. half dollar

(II 42 same -- IV 26 same)

43. Milk is soured by:

1. heat
2. dirty hands
3. bacteria
4. yeast.

(II 43 same -- IV 27 same)

44. Bacteria can be divided into:

1. one group
2. two groups
3. three groups
4. four groups

(II 44 same -- IV 28 same)

45. The meat was spoiled by the action of:

1. bacteria
2. yeast
3. mold
4. all of these working at one time

(II 45 same -- IV 29 same)

46. A man pressed his fingertips against a plate of jelly on which yeast, molds and bacteria can grow. Which grew on the jelly:

1. bacteria
2. yeast
3. mold
4. all three

(II 46 same -- IV 30 same)

47. Bacteria grow faster in a:

1. cool smoky place
2. smoky moist place
3. warm moist place
4. warm smoky place

(II 47 same -- IV 65 same)

48. The scientist washed his hands with:

1. soap and water
2. a strong liquid that kills germs
3. hot water only
4. a rubber hose that sprayed on disinfectant

(II 48 same -- IV 32 same)

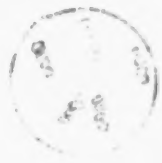
49. Why was the scientist using the bunsen burner: (a gas flame)

1. to sterilize the jelly plates
2. to heat water
3. to heat milk
4. to sterilize the glass slides

(II 49 same -- IV 31 same)

50. This is a microscopic view of:

1. either yeast or mold
2. either bacteria or yeast
3. mold
4. bacteria



(II 50 same -- IV 66 same)

51. This is a microscopic view of:

1. mold
2. bacteria
3. yeast
4. fungi

(II 51 same -- IV 67 same)

52. The woman put jars of fruit in boiling water in order to:

1. pasteurize the fruit
2. dry the fruit
3. can the fruit
4. kill the germs on the outside of the jar

(II 52 same except "4. kill the germs on the outside"--
IV 35 same)

53. In order to preserve the fish, the Eskimos were:

1. freezing it on open-air racks
2. drying it on open-air racks
3. smoking it on open-air racks
4. cooking it on open-air racks

(II 53 same -- IV 36 same)

54. Salt preserves fish by:

1. killing the bacteria and the molds
2. removing the water from the fish
3. keeping off insects
4. cooling the fish

(II 54 same -- IV 37 same)

55. The smoking of meat:

1. kills the yeast
2. kills molds
3. chills the meat
4. dries the meat

(II 55 same -- IV 38 same)

56. In order to sprout, any seed needs:

1. coldness and dampness
2. dryness and warmth
3. dampness and warmth
4. dampness and sunshine

(II 56 same -- IV 68 same)

57. Which will grow without water:

1. bacteria and molds
2. molds and yeast
3. all of these
4. none of these

(II 57 same -- IV 69 same)

58. The two pea plants were:

1. being given different amounts of sunlight
2. being given different amounts of heat and cold
3. being weighed
4. being tested for amount of green color in the plant

(II 58 same -- IV 39 same)

59. Which is spelled incorrectly:

1. bacteria
2. yest
3. mold
4. none of these

(II 59 This item replaced: "Food placed in a freezer doesn't spoil because: 1. the growth of the living things that cause food to spoil is slowed down, 2. some of the living things that cause food to spoil die, 3. air is circulated around the food, 4. both 1 and 2 are correct" -- IV 70 same)

60. Foods spoil less quickly in:

1. cool places
2. warm places
3. damp places
4. cold places

(II 60 same -- IV 71 same)

61. Living things are able to grow faster in:

1. a refrigerator
2. a cool cellar
3. a dry powder
4. a freezer

(II 61 This item replaced: "Frozen foods keep longer than chilled foods because: 1. it is drier, 2. the living things in it that cause spoilage grow more slowly, 3. the living things in it that cause spoilage are dead, 4. it is kept in darkness" -- IV 72 same)

62. Which is correct:

1. the temperature of a refrigerator kills molds and yeasts
2. the temperature of a refrigerator kills bacteria
3. the temperature of a refrigerator slows the growth of molds, yeasts, and bacteria
4. both 2 and 3 are correct

(II 63 This item replaced: "Which is correct: 1. a refrigerator kills mold with cold, 2. a refrigerator kills bacteria with cold, 3. a refrigerator slows down the growth of yeast with cold, 4. both 1 and 3" -- IV 40 same except the stem was changed to: "Which is most correct:")

63. Canning is a good way to preserve food because it:

1. kills the living things that cause foods to spoil
2. prevents new living things from getting into the food
3. dries the food the same time it is cooking it
4. both 1 and 2 are correct

(II 62 same -- IV 41 same)

64. Preserving foods by canning:

1. slows down the growth of the living things
2. prevents living things from entering by the sealing process
3. kills by a high temperature the living things that cause spoilage
4. both 2 and 3 are correct

(II 64 same except "2. removes the oxygen from the jars, 3. kills the living things that cause spoilage, 4. builds up the pressure in the jars" -- IV 42 same)

65. Foods preserved at a canning plant, such as a can of corn, will keep for:

1. days
2. weeks
3. years
4. forever

(II 68 changed from: "Food in cans will keep: 1. for weeks, 2. for years, 3. for months, 4. indefinitely" -- IV 43 same)

66. The temperature of the milk being pasteurized was:

1. 150 degrees
2. 155 degrees
3. 160 degrees
4. 165 degrees

(II 65 same -- IV 44 same)

67. Milk is pasteurized by:

1. holding it at a high temperature for several minutes and killing all the bacteria
2. holding it at a high temperature for several minutes and killing most of the bacteria
3. boiling
4. freezing

(II 66 same -- IV 45 same except 1 and 2 "all" and "most" are underlined)

68. While milk is being pasteurized, the temperature:

1. changes twice
2. changes once
3. changes three times
4. is held constant (never changes)

(II 67 same -- IV 46 same)

69. The temperature of the deep freeze was:

1. 30 degrees above zero
2. 30 degrees below zero
3. 3 degrees above zero
4. 3 degrees below zero

(II 69 same -- IV 47 same)

70. The egg powder, when taken from the machine, would not spoil because:

1. it was too cold to permit anything to grow
2. it was smoked
3. it was too dry to allow anything to grow
4. it was kept in a dark place

(II 70 same -- IV 48 same)

71 Which method uses chemicals to preserve foods:

1. freezing
2. drying
3. light rays
4. none of these

(II 71 same -- IV 73 same except "4. pasteurizing")

72. Which is never useful but always harmful to man:

1. mold
2. bacteria
3. yeast
4. none of these

(II 72 same -- IV 74 same except in the stem "never useful" and "always harmful" were underlined)

73. High temperatures kill:

1. bacteria
2. yeast
3. mold
4. all of these

(II 73 same -- IV 75 same)

74. Growth of the living things that cause foods to spoil can be stopped or slowed down by:

1. heating to a high temperature
2. freezing
3. drying
4. all of these

(II 74 same -- IV 76 same)

75. In a warm place:

1. yeast will grow but bacteria will not
2. yeast will grow but mold will not
3. yeast and bacteria will grow but mold will not
4. yeast, mold, and bacteria will grow

(II 75 same -- IV 77 same)

28. Where do molds grow on most foods:

1. in the middle
2. just below the surface
3. in the air around the food
4. on the surface

(II 28 same -- IV eliminated)

29. There is:

1. one kind of mold
2. two kinds of mold
3. three kinds of molds
4. many kinds of molds

(II 29 same -- IV 60 same)

30. The bubbles in the orange juice were caused by:

1. yeasts
2. yeasts and molds together
3. bacteria
4. spores bursting

(II 30 same except the stem was changed to: "The small 'volcanoes' in the orange pulp were caused by:" and "2. molds" -- IV 19 same except the word "caused" in the stem was changed to the word "made")

31. The bubbles coming up through the orange pulp were made of:

1. carbon dioxide and oxygen
2. carbon dioxide and hydrogen
3. carbon dioxide
4. carbon and iodine

(II 31 same -- IV 20 same)

32. We know that yeasts were at work in the juice because of:

1. its color
2. the bubbles
3. the girl's throwing it down the drain
4. the pulp's settling to the bottom of the glass

(II 32 same -- IV 21 same)

76. In canning, the foods are:

1. cooked and then canned
2. canned and then cooked
3. dried and then canned
4. treated with light rays and then canned

(II 76 same -- IV 49 same)

77. Living things that cause food to spoil and look like this under a microscope are what size:

1. same size as the letter "O"
2. same size as the letter "o"
3. same size as a period "."
4. smaller than a period "."

78. Mold is always a sign of:

1. pasteurization
2. dryness
3. spoilage
4. none of these

(II 78 replaced: "This could be, when looking through a microscope: 1. both a bacteria and a mold, 2. both a yeast and a bacteria, 3. a yeast alone, 4. a bacteria alone" -- IV 18 same)

79. Bacteria give off:

1. carbon dioxide
2. spores
3. light rays
4. none of these

(II added -IV 34 same except "1. hydrogen")

80. Which is correct:

1. molds are smaller than bacteria
2. yeasts are smaller than bacteria
3. molds are larger than bacteria
4. bacteria are larger than yeasts

(II added -- IV 79 same)

Two questions were added to IV:

30. According to size, which could be a yeast:

1. 2. 3. 4.

31. The "mildew" sometimes seen on leather shoes, boots, etc., in damp weather is really caused by:

1. yeasts
2. molds
3. bacteria
4. insects

APPENDIX D

TEST

ATOMS AND MOLECULES

DO NOT WRITE OR MARK ON THIS TEST BOOKLET

1. On slide one, which number is near the model which represents a water molecule?

2. On slide two, which number is near the model illustrating a mixture?

3. On slide three, which number is near the model which represents a molecule of sugar?

4. On slide four, which number is near the model which represents a hydrogen peroxide molecule?

5. On slide five, which number is near the model which illustrates a molecule of carbon dioxide?

6. Slide six. Which of the following does this model represent?

   1. A substance that is in sand
   2. One molecule in a cube of sugar
   3. A mixture of different molecules
   4. A solution of hydrogen peroxide and water

7. Slide seven. Each dot in the photograph(s), as seen in this film, represent a:

   1. Gaseous mixture
   2. Group of atoms
   3. Single atom
   4. Single molecule

DO NOT TURN TO THE NEXT PAGE UNTIL YOU ARE TOLD

9. Which is the correct statement about the number of materials there can be?

1. There can only be about 45 different materials.
2. There are only 3 different materials.
3. There is no definite answer about the number of materials there can be.
4. There are only approximately 100 different materials.

9. How can the chemist continue to make new substances?

1. By making models of different atoms.
2. By finding new ways of chemically combining different atoms.
3. By making new combinations of the letters of the alphabet.
4. By making new atoms whenever they are needed.

10. The letters of the alphabet are to words as:

1. a molecule is to the periodic chart
2. a compound is to a mixture
3. atoms are to mixtures and compounds
4. a solution is to a compound

11. All materials that are now existing or are yet to be developed are made from:

1. mixtures
2. the alphabet
3. atoms
4. solutions

12. What is the preferred way for the scientist to write the names of elements?

1. By using a dictionary
2. By using numbers
3. By using nick-names
4. By using symbols

13. Approximately how many kinds of atoms are listed on the periodic chart?

1. 10
2. 100
3. 500
4. 1000

14. Which of these is <u>not</u> right?

1. O is the symbol for oxygen
2. C is the symbol for carbon
3. A is the symbol for aluminum
4. N is the symbol for nitrogen

15. Which of the following statements about the size of atoms is correct?

1. If all the atoms in a grain of sand were placed end to end, they would reach a mile.
2. A drop of water contains billions upon billions of atoms
3. No one has ever seen an atom
4. We can photograph atoms only in unusually large groups

16. Sn is the symbol for tin. Which of the following is this an example of?

1. Some of the symbols are not abbreviations for the names we commonly use.
2. Some of the symbols are made-up by the person who discovered the element.
3. The symbols for elements have two letters only.
4. The symbols are complicated and hard to learn.

17. What are the smallest particles into which elements can be divided and still be the same substance?

1. Atoms
2. Molecules
3. Compounds
4. Mixtures

18. How do we learn how atoms behave?

1. By looking in the dictionary
2. By cooking in the kitchen
3. By observing them through a microscope
4. By combining different substances to see how they react

19. What do we learn by making models of molecules?

1. How atoms combine into molecules
2. How big atoms are
3. What color atoms are
4. What atoms are made of

20. How are atoms generally found in nature?

1. Separately
2. In the liquid form
3. Broken into pieces
4. In combination with other atoms

21. A molecule:

1. can be seen without a microscope
2. cannot be photographed
3. is usually larger than an atom
4. is never made up of the same combination of atoms

22. Which of the following is made up of molecules?

1. Flour
2. Plastic
3. Cotton
4. Everything

23. If every molecule in one grain of sand suddenly became as big as the grain itself, we could have a cube a foot high, a foot wide, and a foot deep.

1. The statement is true as stated.
2. Substitute atom for molecule to make the statement true.
3. Substitute mile for foot to make the statement true.
4. Substitute sugar for sand to make the statement true.

24. Which of the following combinations does each molecule in a drop of water contain?

    1. 2 atoms of hydrogen and 2 atoms of oxygen
    2. 2 atoms of hydrogen and 1 atom of oxygen
    3. 1 atom of hydrogen and 2 atoms of oxygen
    4. 1 atom of hydrogen and 1 atom of oxygen

25. In the film, what is the liquid that looks like water but is some other liquid?

    1. Iron solution
    2. Baking soda solution
    3. Hydrogen peroxide
    4. Mercury

26. As shown in the film demonstration, what color did the water become when a certain solution was added to it?

    1. Purple
    2. Brown
    3. Dark blue
    4. Colorless

27. In the film, what solution was added to water and to another solution which caused it to bubble?

    1. Sugar
    2. Carbon
    3. Iron
    4. Mercury

28. Which of the following combinations does each molecule of hydrogen peroxide contain?

    1. 2 atoms of hydrogen and 1 atom of oxygen
    2. 2 atoms of hydrogen and 2 atoms of oxygen
    3. 1 atom of hydrogen and 1 atom of oxygen
    4. 1 atom of hydrogen and 2 atoms of oxygen

29. What will usually happen if you combine an additional atom to some molecule?

    1. You will have a larger molecule of the same compound.
    2. Nothing will happen.
    3. An entirely different compound will be formed.
    4. You will have a new element.

30. What do we use to separate water into two gases?

    1. Electricity
    2. A bunsen burner
    3. A microscope
    4. A solution of iron

31. When you change water into hydrogen and oxygen, how many atoms does each molecule of the oxygen have?

    1. One
    2. Two
    3. Three
    4. The same number as in a water molecule

32. Which, if any, of the following can be separated into other substances by Chemical means?

    1. Hydrogen
    2. Iron
    3. Oxygen
    4. None of these

33. What are molecules containing only one kind of atom called?

    1. Solutions
    2. Compounds
    3. Mixtures
    4. Elements

34. Which of the following substances can be separated by chemical means to form other substances?

    1. Water
    2. Carbon
    3. Mercury
    4. Copper

35. Which list contains a substance that is not an element?

    1. Hydrogen, iron, copper
    2. Oxygen, baking soda, stainless steel
    3. Nitrogen, carbon, lead
    4. Mercury, platinum, aluminum

36. The element named carbon comes in different physical forms. Which of the following is not an example of this?

    1. Coal
    2. Graphite
    3. Stainless steel
    4. Diamonds

37. In what forms do elements appear?

    1. Only as gases
    2. Only as liquids or gases
    3. Only as solids, liquids, or gases
    4. Only as solids, or liquids

38. What is the color of the liquid mercury shown in this film?

    1. Purple
    2. Colorless
    3. Brown
    4. Silver

39. What is the color of hydrogen gas?

    1. Colorless
    2. Red
    3. White
    4. Dark blue

40. Which of the following elements is usually in the gaseous form?

    1. Carbon
    2. Iron
    3. Aluminum
    4. Nitrogen

41. Why did the chemist in the film heat the sugar?

    1. To separate the parts of a mixture
    2. To separate the parts of a compound
    3. To combine the molecules of a mixture
    4. To combine the elements of a compound

42. Which of the following will happen when sugar is heated by the bunsen burner flame?

    1. It separates into a new element and a new compound
    2. It stays the same, except it turns black and smokes
    3. It just melts and turns black
    4. It dissolves and gives off yellow smoke

43. In the film when the sugar is heated over the bunsen burner flame, what is the white vapor which collects on the inside of the test tube?

    1. Carbon
    2. Mercury
    3. Carbon dioxide
    4. Water

44. What substances can sugar be separated into?

    1. Carbon, nitrogen, hydrogen
    2. Nitrogen, hydrogen, oxygen
    3. Carbon, nitrogen, oxygen
    4. Carbon, hydrogen, oxygen

45. What do we call materials whose molecules are composed of more than one different kind of atom?

    1. Elements
    2. Compounds
    3. Mixtures
    4. Molecules

46. What is the total number of atoms necessary to make up a molecule of table sugar?

    1. 3
    2. 25
    3. 45
    4. 70

47. Which of the following substances would not ordinarily combine together to form a compound even under favorable conditions?

1. Hydrogen and oxygen
2. Hydrogen, oxygen, and carbon
3. Salt and water
4. Carbon and oxygen

48. When do we know we have a chemical compound?

1. If it contains at least 12 like elements
2. If it contains only one kind of element
3. If it contains 45 or more like elements
4. If it contains 2 or more different kinds of elements

49. In the film we saw a magnet used to separate:

1. Hydrogen and oxygen from water
2. Carbon from sugar
3. Aluminum from sand
4. Iron from salt

50. Some substances contain different molecules which exist side by side but do not unite chemically. What are these substances called?

1. Elements
2. Compounds
3. Mixtures
4. None of these

51. Which of the following groups contains something that is a mixture?

1. Groups 2 and 4
2. Salt and iron filings
3. Hydrogen and oxygen in water
4. Sugar and water

52. What will happen if we add sugar to water?

1. We will have a mixture
2. We will still have sugar molecules
3. The sugar will no longer be in grains
4. All of these

53. Which of the following is an example of a solution?

1. Air
2. Iron filings
3. Oxygen
4. Salt water

54. What will you have if you stir together ground glass and sulphur powder?

1. An element
2. A mixture
3. A compound
4. A solution

55. Which of the following will you have if sugar is added to water?

1. None of these
2. A solution
3. A visible solid
4. A gaseous mixture

56. In the film, what did the chemist taste?

1. None of these
2. Salt molecules
3. Sand molecules
4. Sugar molecules

57. Which of these is a mixture when found in its purest state?

1. Water
2. Sugar
3. Salt
4. Air

58. By the way the chemist has written the composition of these substances, he tells you that only one is a mixture. Which one?

1. $(C_6H_{10}O_5)$ (H_2SO_4) (NH_4OH)

2. $N + O + H + H_2O + CO_2$

3. $CO_2 - H_2O - H - O$

4. H_2O_2

59. Which of the following do we encounter most frequently in our daily lives?

1. Pure elements
2. Pure compounds
3. Mixtures of elements and compounds
4. Pure solutions

60. How should the chemist classify paint?

1. As a mixture
2. As an element
3. As a coumpound
4. As a solution

61. Which of the following is not an example of a mixture?

1. Aluminum
2. Brick
3. Glass
4. Silverware

62. How would the chemist classify wood?

1. As a mixture
2. As a compound
3. As an element
4. 2 and 3

63. Why was distilled water used in the steam iron?

1. Because it contains substances to help the ironing
2. Because ordinary water is a mixture
3. Because it does not evaporate as quickly as ordinary water
4. Because it dampens the clothes

64. Atoms combine to form which of the following?

1. Elements only
2. Compounds only
3. Elements or compounds
4. Elements and electrons

65. Which of the following contains a substance that, even in its pure state, is not a compound?

1. Sugar, salt, water
2. Salt, baking soda, sugar
3. Water, hydrogen peroxide, carbon dioxide
4. Vinegar, baking soda, air

66. How can we classify every kind of substance?

1. As elements and compounds only
2. As elements and mixtures only
3. As compounds and mixtures only
4. As elements, compounds, and mixtures

67. Which is not a mixture?

1. Distilled water
2. Stainless steel
3. Salad dressing
4. Plastic

68. What is another name for atoms given in the film?

1. Protons
2. Electrons
3. Nature's building blocks
4. Molecules

STOP!

APPENDIX E

WHY FOODS SPOIL
SUMMARY OF CHANGES
(First Revision)

1. Inclusion of organizational outline. Original's pioneer sequences were shortened and a two scene cave-man introduction was added.

2. Mold spores floating in air.

3. Emphasis on crucial words by repetition. R1 repeats "molds, yeasts, and bacteria"in scenes 9 (twice), 11, 12, 54, 84, 85.

4. Change in structure of sentence to allow more emphasis on crucial parts (similar to #8)
   O16: "...by watching some food spoil..."
   R1-13: "...by watching them spoil some food..."

   O39: "Like mold, some yeasts are..."
   R1-37: "Some yeasts, like some molds..." (content here is that of a description of yeast)

   O50: "When...eat; when...sour, bacteria are the cause."
   R1-48: "Bacteria are the cause of meats..."

   O75: "Almost all.... We call this pasteurized milk."
   R1-76: "Pasteurized milk is..."

5. Identification. Changed boy and girl to Susan and John
   R1-15

6. Active, rather than, in a sense, passive voice.
   O18: "...the bread should be placed in a dark..."
   R1-15: "John puts the bread into the cupboard..."

7. Clarification of colors.
   R1-19: "Color of bread mold is green."
   R-35: "Yeasts are not really blue but have been stained to help us see them."
   R-42: "He colors them with a stain to help us see them. They are not really pink."

8. Shorten sentences; use fewer words.
   O25: "...there is a sack full of mold seeds. We call these seeds spores."
   R1-23: "...is a sack full of mold seeds called spores."

9. Reinforcement of audio with video. Arrows point out roots and branches of mold.
   R1-44, 45, 46: Overlays on three kinds of bacteria.
   R1-49: "...some bacteria useful." Video of cottage cheese and butter as examples of useful aspect of bacteria.

10. Emphasize differences or comparisons by showing examples of differences.
    R1-28, 29, 30, 31: all show different molds.

11. More exact phrasing.
    038: "...they make the juice turn sour."
    R1-26: "they spoil the juice."

    041: "...makes bread dough rise."
    R1-39: "has puffed up the dough."

    062: "...doing well."
    R1-61: "...growing well."

    079: "...almost indefinitely..."
    R1-75: "...for months and often for years."

    081: "...long time at a low temperature."
    R1-79: "...low temperatures of about 30 degrees below zero."

    075: "...heated to a temperature which kills..."
    R1-76: "...heated to 160 degrees to kill most..."

12. Comparison using before and after shots.
    R1-38 and 39: bread dough with and without CO_2 having been formed by yeast.

13. Explanation of process.
    R1-72: "The heat, like that of boiling water, kills..." (canning)

    085: "Here special light rays are used to destroy the plants that spoil food."
    R1-83: "Here special lights like concentrated sunlight, quickly kill..."

14. Show relation between scenes: indicate reasons for changes, such as in appearance (similar to #20).
    026: "If you take a brush and brush away the mold on bread, you will see the dust rise."
    R1-24: "Our moldy slice of bread has been dried."

15. Size comparison by using student-recognized illustrations.
    025: Video shows sack being broken open, but no audio comment and no size contrast.
    R1-23: "Compare their size with the needle point here used to break the sack."

16. Reinforcement of video with audio.
    0: has no audio on breaking open of sack.
    R1-23: audio is added. "Compare their size here with the needlepoint here used to break the sack.

    R1-59: "...such as these hams in a smokehouse..."
    060: "Many kinds of meat..."

17. Point our directly rather than have student infer. E.g., be more specific about the beneficial aspects of making cheese flavors.
    027: "Certain molds give cheese a special flavor."
    R1-25: "Molds are sometimes beneficial to foods. For instance,..."

056: "...some foods keep longer when dried in the sun."
R1-55: "...take away moisture and food will be preserved."

069: "very low temperatures like those in a freezer..."
R1-68: "Food keeps in refrigerators because..."

18. Reinforcement with overlays. (arrows-titles---)
R1-77, 33, 38, 39, 42, 44, 45, 46, 77, 36-90, 79: (should have arrow pointing to -32 degrees, but it is not in film)

19. Use of disclaimers.
R1-27: "...color and shapes which cannot always be shown accurately in this film..."
R1-35: "Yeasts are not really blue but these have to be stained..."
R1-42: "They are not really pink."

20. Tie in previous learning; show relationship between present content and earlier scenes.
Use of transitions.
R1-28: "Here are three of the many kinds of molds, but are related to the common bread mold."
R1-38: "as in the juice, the yeast..."
R1-48: "Once again, just as with molds and yeasts..."
R1-55: "Remember, we moistened bread..."
R1-60: "similar to the one we have seen with mold and bread."

21. Music as introduction to summary was deleted from R1.

Addition of New Scenes to Original

22. Diagram of pinhead to show size contrasts.

23. Yeast multiplying in orange juice; yeasts are producing CO_2.

24. Longer scene of light rays as preservative.

25. New scene on bread mold.

26. Summary of more difficult parts.

27. Cottage cheese and butter secene added as beneficial aspect of bacteria.

APPENDIX F

WHY FOODS SPOIL

CHANGES MADE IN SECOND REVISION

4-5. THE SENTENCE, "Sometimes new ways of keeping foods were found accidentally," IN FRR IS WITH SCENE 5, BUT IN FR IT IS WITH SCENE 4.

5. "...discovered by accident..." was added.

9. ROLL TITLES CHANGED TO SERIES OF DISSOLVES.

15. VIDEO: New footage showing more distinctly the spores floating in the air.
AUDIO CHANGED FROM: "There are mold seeds floating in the air."
TO
"See the mold spores floating in the air."

16-17. ADDED TO AUDIO: "Why in a dark place? Don't all plants...need sunshine to grow? No."

19. AUDIO CHANGED FROM: "...on bread is seen as green."
TO
"...looks green when found on bread."

20. ARROWS AND OVERLAYS POINTING TO BRANCHES AND ROOTS WERE REMOVED.
AUDIO CHANGED--ADDED: "...what looks like..."

21. AUDIO ADDED: "...like structures..."

23. AUDIO ADDED: "Molds grow from spores."

24. AUDIO CHANGED FROM: "See the dust rise and float away in the air as we brush it. This dust is made up of thousands of tiny spores that have been growing there."
TO
"See the thousands of tiny spores that rise and float about in the air like dust. A new mold plant can grow from each tiny spore."

25. VIDEO: OVERLAY ADDED: "How Molds Help Food"
AUDIO CHANGED FROM: "... to foods. For instance, special flavors in cheeses are sometimes caused by molds."
TO
"For instance, these different kinds of cheese get their distinctive flavors from mold."

25-26-27. AUDIO CHANGED FROM: "With a microscope..."
TO
"In the laboratory..." and "...are not."
TO
"...are harmful."

27. AUDIO CHANGED FROM: "Different molds have different colors and shapes which cannot always be shown accurately in this film."
TO

"There are many kinds of molds found on many things. All are related to the common bread mold."

28-31. OMITTED -- OLD MOLD SCENES

A,B,C,D, E. NEW MOLD SCENES OF DIFFERENT MOLDS OF VARYING COLORS.

32-33. AUDIO CHANGED TO: "But some timy plants that spoil food are almost invisible. Orange juice...is often spoiled by another tiny plany called yeast."

35. AUDIO CHANGED FROM: "To see yeast we must use a microscope."
TO
"These are yeast plants seen through a microscope."

36. ADDED: "...and make it sour."

37. VIDEO -- OVERLAY TITLE ADDED: "How Yeasts Help Food."
AUDIO ADDED: "For example, they make bread fluffy and light."

38. OVERLAY CHANGED TO BOTTOM OF THE FRAME.

42. AUDIO OMITTED: "He colors them with a stain to help us see them. They are not really pink."

44. AUDIO OMITTED: "These pictures show one bacteria from each group."
AUDIO ADDED: "They are not really pink but have been stained to help us see them."

47. AUDIO CHANGED FROM: "...half-dollar coin."
TO: "...fifty-cent piece."

48. NEW SCENE TO EMPHASIZE LESS THE VISUAL IMPRESSION OF THE SPOILED MEAT RECEIVED IN FR AND TO POINT UP THE SPOILED MILK THAT WASN'T SHOWN LONG ENOUGH IN FR.
AUDIO OMITTED: "...are the cause of..."
AUDIO ADDED: "Milk doesn't spoil because it gets warm but because bacteria grow faster when in a warm place."

55. OVERLAY TITLE ADDED: "How Foods Are Preserved."

55-58. SAME AUDIO USED BUT REARRANGED TO HELP REINFORCE THE VIDEO MORE.

59. AUDIO OMITTED: "...in a smokehouse...," "Let's explain why drying foods help preserve them."

60. AUDIO OMITTED: "Two pea seeds, one in wet soil, one in dry. To do this we will try an experiment similar to the one we have seen with mold and bread."

59-60. AUDIO ADDED: "To explain why drying foods preserve them,...let's try this experiment."

62. AUDIO CHANGED FROM: "...that needs moisture to grow."
TO: "...will not grow without water."

63-66. OMITTED -- SECOND PEA PLANT SEQUENCE.

80-82. EGG SEQUENCE PUT TOGETHER WITH THE OTHER "DRYING PROCESSES."

F. NEW CHART POINTING OUT TEMPERATURE EFFECTS ON PLANTS.

78-79. PUT IN NEW ORDER: (HEAT AND WARM BEFORE CHART -- NEW CHART -- FREEZING AND COOLNESS FOLLOWING CHART.)

78. AUDIO CHANGED FROM: "...a long time..."
TO: "...months and sometimes years..."

79. OVERLAY ARM POINTING TO 30° BELOW ON THE THERMOMETER.

67. AUDIO CHANGED FROM: "...tiny plants either do not grow or grow so slowly..."

TO

"...coolness slows down the growth of plants so..."

VIDEO CHANGE: Cut out part of old scene where she opened freezing compartment when talking about coolness.

69-72. AUDIO CHANGED FROM: "A lot of food are preserved by killing molds, yeasts, and bacteria with heat...canning is one of the best ways to keep food from spoiling. The food is placed in jars or cans and cooked. Then it is sealed so that more yeasts, mold, and bacteria... cannot enter.... The heat, like that of boiling water, kills the tiny plants that would make the food spoil. Heat plus the sealing will preserve the food for many months."

TO

"Canning is a way of preserving food by using heat. The food is placed in jars or cans then cooked.... The jars of food are heated in boiling water to kill the tiny plants that would make the food spoil.... When the heat has killed the mold, yeast, and bacteria, the jars are sealed to keep out other plants."

73-75. AUDIO CHANGED FROM: "Many of the foods we eat today are cooked... and sealed in cans at large canneries such as this one.... Food in cans will keep for months and often for years."

TO

"In modern canneries food is sealed tightly in cans and cooked.... Food canned in this way...will keep for months and often years."

76-77. AUDIO CHANGED FROM: "The milk we drink is usually pasteurized. Pasteurized milk is heated to 160° to kill most of the bacteria that would spoil it or cause sickness.... The people who pasteurize milk must be very careful to keep the milk exactly the right temperature."

TO

"Pasteurization is a process of heating the milk so that most, but not all, of the bacteria that would spoil the milk or cause sickness are killed. The people who pasteurize...milk must be very careful to keep the milk exactly at 160°.

83. AUDIO OMITTED: "We know that..."

84. SUMMARY TITLES CHANGED TO A SERIES OF DISSOLVES.

G. NEW CHART ADDED SHOWING RELATIVE SIZES OF YEAST, MOLD, AND BACTERIA.

87. OVERLAY TITLE CHANGED FROM "CANNING" TO "HEATING."

APPENDIX G

ATOMS AND MOLECULES
(Film Continuity)

ORIGINAL VERSION

LEADER -- 6'

EB FOCUS TITLE -- 10'(Music In)

MAIN TITLE -- 15'

CREDIT TITLE -- 19'

1. Rushing Water -- 23' (Music Out)

2. Roots in Water -- 26'

3. Cattails in Wind -- 29'
   NARRATOR: What is the world made of?

4. CU leaf -- 31'
   How many different materials are there?

5. Flowering Plant -- 32'
   There's no definite

6. Flour pouring from sifter; two children making cake -- 40'
   answer to this question.
   Every day, new materials are being made. In fact, you might have made some new materials yourself, if you've ever experimented in the kitchen.

7. CU cake batter with spoon in it -- 42'

8. CU boy's face looking up and turning around -- 44' (Music)

9. CU burner on kitchen stove -- 45' (Music)

10. Boy opening stove; smoke coming out; girl comes in while boy is taking cake out of oven -- 51' (Music)

11. CU boy and girl looking at oven and at cakes -- 52' (Music out)

12. CU smoke clearing so we can see cakes -- 56'
    Here's a new material that never existed before...and probably never will again.

13. CU hand washing dishes -- 64'
    We use many new materials every day. Stainless steel is a new material. So are the hundreds of plastics we use today.

14. Woman washing dishes; puts dish in drainer -- 67'
    But how can we keep making new materials? Isn't there a limit?

15. CU dictionary gradually getting smaller with hands coming in scene, then boy. He pages through dictionary -- 76'

Let's ask another question. Is there a limit to the number of words we can use? You know that there isn't, since we're always adding new words to our language. Yet all the words in the dictionary are made up of something much simpler...

16. CU finger moving down column of words in dictionary -- 33'
the letters of the alphabet! These letters are the building blocks from which all words are made.

17. Periodic chart of the atoms -- 89'
This is a chart of the building blocks from which all materials are made. These building blocks are called atoms.

18. Individual parts of atomic weight chart -- 100'
Each atom has a name, and also a symbol. There are more than one hundred different atoms. From them, all the materials we know are made.

19. CU oxygen part of chart -- 105'
The symbol O stands for oxygen. This chart has other information too for chemists to use.

20. CU carbon part of chart -- 108'
C stands for carbon.

21. CU hydrogen part of chart -- 110'
H stands for hydrogen.

22. CU Aluminum part of chart -- 112'
Al stands for aluminum.

23. CU iron part of chart gradually fading back to original atomic weight chart -- 120'
Fe stands for the Latin name for iron. Some of the symbols are not like the names we commonly use, but it doesn't take long to learn these symbols.

24. CU drop of water -- 125'
Atoms are so small that a single drop of water contains billions upon billions of them.

25. Woman looking into microscope -- 131'
They are so small that no one has ever seen them, even with the most powerful microscopes. With such microscopes, we have

26. Groups of atoms - 133'
been able to photograph unusually large groups of atoms.

27. Separate atoms which make up group -- 137'
But the separate atoms which make up these groups are far too small to be seen.

28. Individual atoms -- 140'
But by observing

29. CU models of atoms gradually getting smaller. Hand picks up one model.
Picture of a group of atoms -- 149'
how materials behave, we have learned how atoms behave, and we have made models of atoms to help us learn more about them. Atoms are almost never found separately in nature. They combine with other atoms.

30. CU hands with models of atoms building onto group -- 156'
According to natural laws which chemists know. These combinations are called molecules.

31. Table setting. Hands pouring water into glass -- 159'
Every material is made of its own kinds of molecules.

32. CU glass with water -- 161'
There are water molecules.

33. CU salt shaker -- 163'
salt molecules...

34. CU glass with sugar in it -- 164"
sugar molecules...

35. CU napkin -- 167'
molecules that form cotton...

36. Table setting. Hands putting dish on saucer, and silverware on table -- 172'
molecules that form plastic dishes. Each different molecule is made up of different combinations of atoms.

37. CU model of molecule of sugar; hand turning it -- 177'
This model represents a molecule of sugar. Molecules may contain many atoms, but they are still very small.

38. A grain of sand increasing in size and encompassing scene; buildings along skyline with illustration of a cube -- 191'
If every molecule in one grain of sand suddenly became as big as the grain itself, we would have a cube a mile high, a mile wide, and a mile deep.

39. CU models of three atoms; pencil pointing out names -- 202'
Here we have combined models of three atoms into a molecule that consists of two atoms of hydrogen and one atom of oxygen. Chemists write this formula H_2O.

40. CU drop of water -- 211'
Yes, this is a formula for water. A drop of water contains billions of molecules, each with two hydrogen atoms and one oxygen atom.

41. Two containers of liquid -- 213'
Both of these liquids look like water.

42. CU liquid -- 215'
But this is not water.

43. Two containers. Hand with third container pouring solution into two containers -- 221'
It acts quite differently as you will see when we pour a solution of iron in each liquid.

44. Container with hydrogen peroxide -- 222'
This is hydrogen peroxide.

45. CU bubbling liquid with H_2O superimposed -- 225'
Its formula is H_2O_2.

46. Container of peroxide with 4 molecules in front. Camera pans to other container with 3 molecules in front -- 232'
Each molecule contains two atoms of hydrogen and two of oxygen. That is, one more oxygen atom than a molecule of water.

47. Two containers with molecules in front of each -- 236'
So you see that one atom more or less in a molecule...may result in a great change in the nature of the material.

48. Bubbling brown liquid -- 23?'

49. Hand moving electrical clip into scene. Camera pans to tubes with hydrogen and oxygen -- 247'
By using electricity, we can separate water into two gases which form each molecule of water, hydrogen and oxygen. Since each molecule of these gases

50. CU H_2 tube -- 250'
contains two atoms, the chemical symbols are H_2

51. Cu O_2 tube -- 252'
and O_2.

52. Three tubes H_2 H_2O O_2 -- 259'
But hydrogen cannot ordinarily be separated into other materials. Neither can oxygen. For this reason, hydrogen and oxygen are called elements.

53. CU hydrogen part of atomic weight chart -- 260'
The molecules of elements

54. CU oxygen part of atomic weight chart -- 261'
contain only one kind of atom.

55. CU carbon part of chart, gradually getting smaller until most of chart is shown -- 266'
Therefore there are as many different elements as there are different kinds of atoms.

56. Woman washing aluminum pan and iron frying pan -- 270'
Aluminum is an element since it contains only one kind of atom. Iron is an element.

57. Spool of copper wire -- 276'
So is copper.

58. Hand (CU) with platinum engagement ring -- 278'
Other elements include platinum

59. Lead fishing weight -- 281'
and lead.

60. Different forms of carbon -- 288'
Some elements, like carbon, come in different forms.

61. Hand with container pouring liquid into another container. Pan to tubes of oxygen, hydrogen, and nitrogen -- 299'
A few elements, like mercury, are usually seen as liquids. A number of elements, like oxygen, hydrogen, and nitrogen are usually found as gases and must be kept in containers.

62. Man pours sugar into tube; holds tube over burner -- 316'
But most materials are made of more than one kind of atom. We find that ordinary table sugar, when heated, will separate into other materials.

63. CU tube over burner. Camera moves to top of tube and we see smoke and droplets of water -- 314'
The white sugar turns black and gives off a vapor. You can see this vapor condensing at the top of the tube. These are drops of water or H_2O.

64. CU carbon from tube; glass muddler breaking carbon -- 322'
The material left in the bottom of the tube is carbon. So sugar is not an element, since it can be broken down into hydrogen, oxygen, and carbon.

65. Hands pouring water into H_2O tube. H_2 and O_2 tubes in background -- 327'
We have already seen that water can be separated into hydrogen and oxygen. So water is not an element.

66. Series of model molecules. Hand picks up model of water, sets it down; picks up sugar model, sets it down -- 346'
Materials whose molecules are made up of more than one kind of atom are called compounds. Water is a compound, since each molecule contains atoms of hydrogen and oxygen. Sugar is a compound of hydrogen, oxygen, and carbon. It takes 45 of these atoms to make one molecule of sugar.

67. Hand picking up small container and pouring salt in with iron filings in second container. Glass muddler mixes it -- 351'
Here we are mixing salt with iron filings to illustrate a third kind of material

68. CU container with muddler mixing contents. Mixing stops after a while -- 355'
called mixtures. In mixtures, different materials exist side by side, and can often

69. CU clip holding magnet. Hand pouring different materials over magnet. Some cling, others drop on dish -- 363'
be separated easily from one another...as we do here with the help of a magnet.

70. Models of molecules. Big group in center, small groups surrounding big one -- 371
These models show what happens when we mix sugar and water. The molecules exist side by side, and do not change.

71. Two containers. Hand pours water, in one container, into container with sugar -- 374'
Now let's do the experiment.

72. CU sugar in container. Water poured into it, and let stand -- 381'
The sugar dissolves, but neither the sugar molecules nor the water molecules change. They exist side by side in solution.

73. Fingers holding container with sugar -- 387'
If we permit the water to evaporate...we have the sugar left no longer in grains, but it is sugar...

74. Man testing sugar -- 390'
as we can tell by tasting it.

75. River with trees and shrubs. Camera pans to sky. Letters superimposed on sky. Circles around last two. Lettering off sky -- 413'
Air is the most common mixture. It contains a number of elements, like nitrogen, oxygen, argon, and neon, plus compounds like water vapor and the gas carbon dioxide, to say nothing of dust, smoke, and other impurities. Notice the plus signs? This is how the chemist indicates a mixture...as distinguished from compounds in which the symbols for the atoms written together. Most things around you are mixtures.

76. Wood; hand holding paintbrush and painting wood red -- 416'
Paint is a mixture of coloring matter and liquid.

77. Steps, woodwork being painted; camera pans to bookcase with books, and finally wood walls -- 423'
Any material that contains more than one kind of molecule is a mixture. Wood is one of the most common mixtures.

78. Hands over sink with dishes. Rinses funnel with water. Hand puts funnel in steam iron on sink and pours distilled water into iron -- 432'
Even the compound, water, often contains other materials and is actually a mixture. Only pure distilled water is a true compound.

79. Boys fishing in stream. Cattails foreground, 3 boys middle, and waterfalls background -- 435'
So we see that all the materials of our world are made up of various combinations of atoms.

80. CU boy sitting on rock fishing, back to camera, facing waterfalls -- 440'
These atoms combine into molecules to form three kinds of materials.

81. CU aluminum strainer and iron frying pan. Word elements superimposed over scene (stove) -- 445'
Materials like aluminum and iron whose molecules are made up of only one kind of atom are called elements.

82. Salt, baking soda, and sugar in glass. Two bowls in back. Compounds on screen -- 450'
Materials whose molecules are made up of more than one kind of atom are called compounds.

83. Camera pans to CU of salt, baking soda box, and sugar in glass -- 458'
These include salt, and many other common materials like baking soda, and, as we have seen, sugar.

84. CU cabbage, tomato, and salad dressing. Word mixtures superimposed over scene -- 461
Materials which contain different molecules existing side by side are called mixtures.

95. Part of atomic weight chart, smaller and smaller until whole chart is shown --474' (Music In)
All of them are made up of nature's building blocks...The more than one hundred different atoms of which the world is made.

END TITLE -- 477'

FILMS IN SERIES -- 494'

APPENDIX B

ATOMS AND MOLECULES
(Film Continuity)

REVISED VERSION

LEADER -- 6'

EB FOCUS TITLE -- 10'

MAIN TITLE -- 15'

CREDIT TITLE -- 19'

1. RUSHING WATER -- 23' (MUSIC CUT) QUESTION SUPERIMPOSED ON SCENE.

   How many different materials are there?

2. ROOTS IN WATER -- 26'

   There are thousands of kinds of materials that make up living things like...

3. CATTAILS IN WIND -- 29'

   Timothy

*4. CU LEAF -- 31' NEW SCENE

   leaves

*5. CU FLOWER -- 32' NEW SCENE

   and flowers

*A. SHOT OF SOMETHING IN THE NON-LIVING CATEGORY -- APPARATUS ON A LABORATORY TABLE

   There are also thousands of kinds of materials that make up non-living things like...

*B. SHORT CU SHOTS OF PLASTIC, METAL, GLASS. AUDIO WILL NAME THEM AS SHOWN.

   Plastic, metal, and glass.

6. FLOUR POURING FROM SIFTER: TWO CHILDREN MAKING CAKE -- 40'

   Actually, there can be no definite answer to our question since new materials are continually being made.

7. CU CAKE BATTER WITH SPOON IN IT -- 42'

   In fact, if you've ever experimented in the kitchen, you might have made some new materials yourself.

---

* Designates new scenes or sequences

8. CU BOY'S FACE LOOKING UP AND TURNING AROUND -- 44' (MUSIC)

9. CU BURNER ON KITCHEN STOVE -- 45' (MUSIC)

10. BOY OPENING STOVE: SMOKE COMING OUT: GIRL COMES IN WHILE BOY IS TAKING CAKE OUT OF OVEN -- 51' (MUSIC)

11. CU BOY AND GIRL LOOKING AT OVEN AND AT CAKES -- 52' (MUSIC OUT)

12. CU SMOKE CLEARING SO WE CAN SEE CAKES -- 56'

13. CU HAND WASHING DISHES -- 64'

We use many new materials every day. Stainless steel is one example. Modern plastics are another.

14.. WOMAN WASHING DISHES: PUTS DISH IN DRAINER -- 67'

But how can we keep making new materials? Isn't there a limit?

*C. ORGANIZATIONAL OUTLINE. (A SERIES OF 3 TITLES GOING FROM ONE TO THE OTHER BY DISSOLVES.)

This film will help answer these questions. It will show that the world is made of nature's building blocks called atoms and molecules,... and how they form elements, compounds, and mixtures. In this film we will learn that elements combine chemically to form compounds; that compounds can be broken down into their elements; and that mixtures are made of materials that are not chemically combined.

15. CU DICTIONARY GRADUALLY GETTING SMALLER WITH HANDS COMING IN SCENE, THEN BOY. HE PAGES THROUGH DICTIONARY -- 76'.

To understand how we can continue to form new substances, let's compare atoms to the letters of the alphabet.

*16. BOY IS LOCATING A WORD. FINGER MOVES <u>SLOWLY</u> DOWN COLUMN OF WORDS IN DICTIONARY AND FINALLY FOCUSES FOR A SECOND ON THE WORD, "PERIODIC TABLE."

Letters are the building blocks from which all words are made, and we're always adding new words to the dictionary.

*17. CU OF TITLE, "PERIODIC TABLE OF THE ELEMENTS" ZOOM BACK TO CHART <u>HANGING ON WALL</u>.

In the same way, the more than 100 different atoms we find listed on the periodic table are the building blocks from which all materials are made.

18. PAN OF FIRST FOUR ROWS OF PERIODIC TABLE.

These atoms in various combinations make up everything in the world. Each atom has a name, and also a symbol.

19. BEGINNING OF A SERIES OF DISSOLVES SHOWING CU OF OXYGEN PART OF TABLE SHOWING SYMBOL THEN ZOOMING IN ON NAME.

    The symbol "O" stands for oxygen.

20. DISSOLVE TO CU CARBON PART OF TABLE SHOWING SYMBOL THEN THE NAME.

    "C" is the symbol for carbon.

21. DISSOLVE TO CU HYDROGEN PART OF TABLE SHOWING SYMBOL THEN THE NAME.

    "H" is the symbol for hydrogen.

22. DISSOLVE TO CU ALUMINUM PART OF TABLE SHOWING SYMBOL THEN THE NAME.

    "Al" is the symbol for aluminum.

23. DISSOLVE TO CU IRON PART OF TABLE SHOWING SYMBOL THEN THE NAME, GRADUALLY PULLING BACK TO ORIGINAL PERIODIC TABLE.

    "Fe" is the symbol for iron. It comes from the Latin name for iron, and some of the symbols are also unlike the names we commonly use.

24. CU DROP OF WATER -- 125'

    Atoms are so small that a single drop of water contains billions upon billions of them.

*25. DR. MUELLER AND HIS FIELD ION MICROSCOPE.

    Atoms are so small that until August, 1955, no one had ever seen them. Dr. Erwin Mueller became the first man to...

26. DR. MUELLER LOOKING INTO MICROSCOPE.

    ...see and to photograph an atom as a result of his invention of the field ion microscope. This microscope is the most powerful in the world...

27. PHOTOGRAPH OF A PLATINUM ATOM.

    Capable of magnifying the specimen some two million times.

28. CU OF PART OF THE PHOTOGRAPH WITH ARROW POINTING TO INDIVIDUAL ATOMS.

    Now the atoms seen here as individual dots are visible.

*29. HAND PICKS UP ONE ATOM OF CARBON AND TWO ATOMS OF OXYGEN AND PUTS THESE TOGETHER. CU OF COMPLETED CO_2 MODEL WITH POINTER INDICATING ATOM OF CARBON AND ATOMS OF OXYGEN. <u>OVERLAY CO_2</u>

    Even before the first viewing of an atom, scientists were able to imagine their structure and to build models of them. Models help scientists to understand how atoms combine into molecules. Atoms are almost never found separately in nature, but in combinations, such as carbon and oxygen. One atom of carbon and two atoms of oxygen form one molecule of carbon dioxide, known chemically as CO_2.

30. CU OF MOLECULE MODEL OF SUGAR. HAND TURNS MODEL AROUND. (YOU CAN USE SCENE FO 37 -- 177' SINCE WE ARE OMITTING THIS SCENE FOR A MOLECULE OF SAND.)

Here is a model of a more complex substance -- a molecule of sugar.

31. TABLE SETTING. HANDS POURING WATER INTO GLASS -- 159' OVERLAY TITLE -- MOLECULES.

Every material is made of its own kinds of molecules.

32. CU GLASS WITH WATER -- 161'

There are water molecules...

33. CU SALT SHAKER -- 163'

and salt molecules...

34. CU GLASS WITH SUGAR IN IT -- 164'

and sugar molecules...

35. CU NAPKIN -- 167'

molecules that form cotton...

36. TABLE SETTING. HANDS PUTTING DISH ON SAUCER, AND SILVERWARE ON TABLE --172'

Molecules that form plastic dishes. Every kind of material has its own particular combination of atoms.

*37. CU MODEL OF A SUBSTANCE IN SAND: HAND TURNING IT.

This model represents one of the substances that make up sand. A molecule may contain many atoms, yet it is still very small.

38. A GRAIN OF SAND INCREASING IN SIZE AND ENCOMPASSING SCENE: BUILDINGS ALONG SKYLINE WITH ILLUSTRATION OF A CUBE -- 191'

If every molecule in one grain of sand suddenly became as big as the grain itself, we would have a cube one mile high, one mile wide, and one mile deep.

*39. CU HAND PUTS TOGETHER THREE ATOMS: ROD POINTING OUT ATOMS. OVERLAY H_2O.

When two atoms of hydrogen are combined with one atom of oxygen we get a molecule which chemists call H_2O. Yes, this is the formula for water.

40. CU DROP OF WATER -- 211'. OVERLAY H_2O.

A drop of water contains billions of molecules, each with two hydrogen atoms and one oxygen atom.

*41. TWO CONTAINERS OF LIQUID SHOWING THE BEAKERS IN THEIR ENTIRETY AND MODELS IN FRONT OF EACH. ALSO THE BEAKERS SHOULD BE LABELED (WATER, H_2O AND HYDROGEN PEROXIDE, H_2O_2)

Both of these liquids look like water.

42. PAN OVER TO H_2O_2 AND GET A WHOLE SHOT OF MODEL AND BEAKER WITH LABEL.

But this is not water. It is a solution of hydrogen peroxide.

D. CU OF BEAKER OF IRON SOLUTION BEING PICKED UP LABELED IRON SOLUTION.

When a solution of iron...

43. TWO CONTAINERS LABELED WITHOUT MODELS IN FRONT: HAND WITH THIRD CONTAINER POURING SOLUTION INTO TWO CONTAINERS.

... is poured into each liquid. They act quite differently.

45. CU BUBBLING LIQUID -- 225'.

Each hydrogen peroxide molecule...

46. CONTAINER OF PEROXIDE WITH LABEL BUT WITHOUT MODEL: CAMERA PANS TO OTHER CONTAINER WITH LABEL WITHOUT MODEL.

Contains two atoms of oxygen; while each water molecule has only one atom of oxygen.

47. TWO CONTAINERS -- LABELED -- WITHOUT MODELS

The iron solution captures the second oxygen atom in the hydrogen peroxide.

48. BUBBLING BROWN LIQUID -- 238'.

This experiment indicates that one atom more or less in a molecule may result in a great change in the nature of the substance.

*E. TITLE ATOMS)
MOLECULES) (GRAY)
ELEMENTS (STANDS OUT)

Elements are made of tiny particles called molecules and molecules are made of even smaller particles called atoms.

*53. CU HYDROGEN PART OF ATOMIC WEIGHT CHART -- 260'

All the atoms and molecules

54. CU OXYGEN PART OF ATOMIC WEIGHT CHART -- 261'

...of one element are similar...

55. CU CARBON PART OF CHART, GRADUALLY GETTING SMALLER UNTIL MOST OF CHART IS SHOWN -- 266'

...to each other but different from those of other elements.

*F. CU DISSOLVE SHOTS OF COAL, GRAPHITE, DIAMONDS.

The element carbon comes in different forms such as coal, graphite, and diamonds.

56. WOMAN WASHING ALUMINUM PAN AND IRON FRYING PAN -- 270'.

Aluminum is an element since it contains only one kind of atom. Iron is an element.

57. SPOOL OF COPPER WIRE -- 276'.

So is copper.

58. HAND (CU) WITH PLATINUM ENGAGEMENT RING -- 278'.

Other elements usually seen as solids include platinum,

59. LEAD FISHING WEIGHT -- 281'.

and lead.

61. HAND WITH CONTAINER POURING MERCURY LIQUID INTO ANOTHER CONTAINER. PAN TO BOTTLES OF OXYGEN, HYDROGEN, AND NITROGEN -- 299'.

A few elements, like mercury, are usually seen as liquids. A number of elements, like oxygen, hydrogen, and nitrogen are usually found as gases and must be kept in containers. These three gases are colorless.

*62. MAN POURS SUGAR FROM JAR LABELED -- POURS INTO TUBE: OVERLAY TITLE -- COMPOUNDS: HOLDS TUBE OVER BURNER.

Chemists know how to combine elements to make compounds, and how to break down these compounds. Ordinary table sugar, when heated, will separate into other materials.

63. CU TUBE OVER BURNER. CAMERA MOVES TO TOP OF TUBE AND WE SEE SMOKE AND DROPLETS OF WATER -- 314'. OVERLAY TITLE H_2O OVER SHOT OF VAPOR AT TOP OF TUBE.

The sugar turns to a black carbon and gives off water vapor. You can see this vapor condensing at the top of the tube. These are drops of water, or H_2O.

64. CU CARBON FROM TUBE: GLASS MUDDLER BREAKING CARBON -- 322'. OVERLAY TITLE CARBON.

Carbon is left in the bottom of the tube. We can see that sugar is not an element, but a compound, since it can be broken down into different substances, water, and carbon.

*65. HAND POURING WATER INTO H_2O TUBE. H_2 AND O_2 TUBES IN BACKGROUND. (WATER IS NOT BUBBLING.) OVERLAY ARROW POINTING TO H_2O.

The formula for water tells us it is made of hydrogen and oxygen... two of the same elements that are in sugar. These elements are gases as we saw earlier.

G. SIX VOLT AUTO BATTERIES WITH LEAD WIRES GOING TO ELECTROLYSIS APPARATUS.

By using electricity...

49. HAND MOVING ELECTRICALLY SLIPS INTO SCENE. CAMERA PANS TO AND UP TUBES WITH HYDROGEN AND OXYGEN. POP ON ARROWS POINTING TO H_2 and O_2 TO CORRESPOND WITH THE AUDIO.

...we can separate water into the two gases -- hydrogen and oxygen -- which form each molecule of water. Each molecule of these gases contains two atoms; therefore, the chemical...

50. CU H_2 TUBE.

formulas for these substances are H_2...

51. CU O_2 TUBE.

and O_2.

52. THREE TUBES: H_2 H_2O O_2.

Hydrogen cannot be separated into other materials. Neither can oxygen. For this reason, hydrogen and oxygen are called elements.

66. SERIES OF MODEL MOLECULES. HAND PICKS UP MODEL OF WATER. (OVERLAY H_2O -- LEFT HAND CORNER), PICKS UP SUGAR MODEL, SETS IT DOWN. (OVERLAY $C_{12}H_{22}O_{11}$ -- 346'.

These models illustrate that compounds are substances whose molecules are made up of more than one kind of atom. A water molecule is a compound made up of hydrogen and oxygen atoms. This model of a sugar molecule shows that sugar is a compound of hydrogen, oxygen, and carbon. It takes 45 of these atoms to make one molecule of sugar.

67. OVERLAY TITLE MIXTURES AT BEGINNING OF SCENE. HAND PICKING UP SMALL CONTAINER AND POURING SALT IN WITH IRON FILINGS IN SECOND CONTAINER. GLASS MUDDLER MIXES IT -- 351'.

A third kind of material -- mixtures -- can be illustrated by...

68. CU CONTAINER WITH MUDDLER MIXING CONTENTS. MIXING STOPS AFTER A WHILE -- 355'.

mixing iron filings with salt.

69. CU CLIP HOLDING MAGNET, HAND POURING DIFFERENT MATERIALS OVER MAGNET. SOME CLING, OTHERS DROP ON DISH. OVERLAY TITLE AND ARROW POINT TO IRON FILINGS AND TITLE AND ARROW POINTING TO SALT.

In mixtures, unlike compounds, different substances...do not chemically combine but retain their individual characteristics.

*71. SUGAR IS POURED FROM SUGAR JAR -- LABELED -- AND STIRRED IN WATER.

When we put sugar in water the sugar dissolves forming a special kind of mixture...

72. CU OF SOLUTION BEING STIRRED. OVERLAY SUGAR SOLUTION.

...called a solution. The two substances in this solution are still sugar and water.

73. FINGERS HOLDING CONTAINER WITH SUGAR -- 387'.

If we permit the water to evaporate,the sugar and water will become completely separate again. The water molecules form water vapor and the sugar molecules form solid crystals of sugar...

74. MAN TASTING SUGAR -- 390'.

...as we can tell by tasting it.

70. MODELS OF MOLECULES. BIG GROUP IN CENTER, SMALL GROUPS SURROUNDING BIG ONE. -- 371'.

These models of sugar and water show what happens when we mix the two. The molecules do not change but rather exist side by side. We still have sugar molecules and we still have water molecules.

75. RIVER WITH TREES AND SHRUBS. CAMERA PANS TO SKY. LETTERS SUPERIMPOSED ON SKY. CIRCLES AROUND LAST TWO. LETTERING OFF SKY -- 413'.

Air is a mixture of gases. It contains a number of elements like nitrogen, oxygen, argon, and neon, plus compounds like water vapor and the gas carbon dioxide, to say nothing of dust, smoke, and other impurities. Notice the plus signs? This is how the chemist indicates a mixture...as distinguished from compounds in which the symbols for the atoms are written together. Most of the different things around you are mixtures of elements and compounds.

77. CAMERA PANS ON PLASTIC, BRICK, GLASS, AND WOOD. AUDIO NAMES THESE AS THEY ARE SHOWN.

Plastic, ...brick, ...glass, ... and wood are mixtures. Any material that contains more than...

*H. SHOT OF OPEN PAINT BUCKET WITH BLUE PAINT -- TO PREFACE NEXT SCENE. BRUSH BEING TAKEN FROM BUCKET.

One kind of molecule is a mixture.

76. WOOD: HAND HOLDING PAINTBRUSH AND PAINTING WOOD BLUE -- 416'.

Paint is a mixture of coloring matter and liquid.

78. HANDS OVER SINK WITH DISHES. RINSES FUNNEL WITH WATER. HAND PUTS FUNNEL IN STEAM IRON ON SINK AND POURS DISTILLED WATER INTO IRON -- 432'.

The water we drink is really a mixture because it contains gases and minerals in solution. Only pure distilled water is a true compound.

79. BOYS FISHING IN STREAM. CATTAILS FOREGROUND, THREE BOYS MIDDLE, AND WATERFALLS BACKGROUND.

So we see that all the materials of our world are made of various combinations of atoms.

80. CU BOY SITTING ON ROCK FISHING, BACK TO CAMERA, FACING WATERFALLS. __ 440'.

These atoms combine into molecules to form elements, compounds, and mixtures.

*I. TITLE ELEMENTS

Elements contain only one kind of atom and may be either solids, liquids, or gases. Elements shown in this film were...

J. CU SHOTS OF ELEMENTS -- AUDIO WILL NAME THESE AS THEY ARE SHOWN.

Aluminum, iron, copper, platinum, lead, carbon, and oxygen, hydrogen, and nitrogen.

K. TITLE COMPOUNDS

Compounds consist of two or more elements in chemical combination.

L. CU SHOT OF ELECTROLYSIS PROCESS AND SHOT OF HEATING SUGAR TO CORRESPOND WITH AUDIO.

Water was separated by electrolysis into the elements hydrogen and oxygen. Sugar was separated by heat into water and carbon.

M. CU SHOTS OF COMPOUNDS -- AUDIO WILL NAME THEM.

Some other compounds are salt, baking soda, hydrogen peroxide, and carbon dioxide.

N. TITLE MIXTURES

In mixtures there are no changes in the different kinds of molecules. They just exist...

O. SHOT OF SALT AND IRON FILINGS AND SHOT OF SUGAR AND WATER SOLUTION.

...side by side and do not chemically combine. Salt plus iron filings and the solution of sugar and water were used to illustrate this. Several other examples of mixtures are:

P. CU SHOTS OF MIXTURES -- AUDIO NAMES THEM AS THEY ARE SHOWN.

Wood, paint, plastics, and stainless steel.

*85. PART OF ATOMIC WEIGHT CHART, SMALLER AND SMALLER UNTIL WHOLE CHART IS SHOWN -- 474'.

Most things around us are mixtures of elements and compounds and are made up of nature's building blocks.... The more than one hundred different kinds of atoms of which everything in the world is made.

END TITLE

APPENDIX I

ATOMS AND MOLECULES

TITLES THAT WERE ADDED TO THE REVISION

C. Titles for Introductory Organizational Outline

Nature's Building Blocks

ATOMS
MOLECULES

Atoms and Molecules Form:

ELEMENTS
COMPOUNDS
MIXTURES

ELEMENTS - combine chemically to form compounds

COMPOUNDS - can be broken down into their elements

MIXTURES - are made of materials that are not chemically combined

E. Title: ATOMS) (gray)
MOLECULES)
ELEMENTS (stands out)

I. Summary Title: ELEMENTS

K. Summary Title: COMPOUNDS

N. Summary Title: MIXTURES

SCENES WHERE LABELS WERE ADDED IN NEW FOOTAGE

28. Arm is used to point to individual atoms on the photograph

D, 41-48. Beakers of liquid labeled (water, H_2O; hydrogen peroxide, H_2O_2), and Iron solution

62. Sugar jar labeled

71. Sugar jar labeled

M. Box of salt and baking soda clearly identified

USED IN REVISION
OLD SCENES WHERE LABELS OR OVERLAYS USED

38. Cube: one mile high, one mile wide, one mile deep

61. Bottles labeled for gases they contain: oxygen, hydrogen, nitrogen

65,G,49.
50,51,52. Labels on electrolysis apparatus

H_2 - H_2O - O_2 (New footage but labels were also in old footage)

75. Symbols for the following were superimposed on the sky: nitrogen, oxygen, argon, neon, water vapor, carbon dioxide

78. Bottle of distilled water labeled

ATOMS AND MOLECULES

OVERLAY TITLES ADDED IN FIRST REVISION

1. How many different materials are there?

29. CO_2 (over model)

31. Molecules

39. H_2O (over model)

40. H_2O (over CU drop of Water)

62. Compounds

63. H_2O (next to top of test tube)

64. Carbon (next to carbon on table)

65. Arm pointing to H_2O label on electrolysis apparatus.

49. Pop on arrows pointing to H_2 and O_2 on electrolysis apparatus

66. H_2O (when water molecule is being turned around)
$C_{12}H_{22}O_{11}$ (when sugar molecule is being turned around)

67. Mixtures

69. Iron filings and salt with arrows pointing these out.

72. Sugar solution (over beaker)

ATOMS AND MOLECULES

NEW VIDEO SCENES IN THE FIRST REVISION

4. CU of a leaf.

5. CU of a flower.

A. Apparatus on a laboratory table (non-organic).

B. Short CU shots of plastic, metal, and glass apparatus.

C. Three titles for Introductory Organizational Outline.

16. Finger runs down page of dictionary and stops on CU of the word "Periodic Table."

17-23. New Periodic Chart used. It has the names of the symbols on it.

(Scene 18 -- Pan of table is fast and jerky)

(Scene 23 -- Double zoom back is bad; audio rushed)

25-29. Dr. Mueller, his field ion microscope, and photograph of platinum atoms.

29. Hands assembling model of CO_2; a pointer is used to point up the one atom of carbon and the two atoms of oxygen.

37. CU model of a substance in sand.

39. Hand assembles three atoms (H_2O) and points out different atoms.

D, 41-48. Beakers of water and hydrogen peroxide and flask of iron solution all appropriately labeled.

E. TITLE ATOMS } (gray)
MOLECULES }
ELEMENTS (stands out)

53-55. New chart used again.

F. Shots of coal, graphite, diamonds.

62. Man pours sugar from labeled container into test tube.

63,G, 49
50,51,52. Reshooting of electrolysis process. New scene G shows batteries being hooked up for the electricity.

71. Sugar being poured from labeled jar into test tube.

H, 76. Shot of open paint bucket and painting piece of wood.

I, P. Summary titles and review CU shots.

85. New Periodic Table used again.

ATOMS AND MOLECULES
(Revisions)

REASONS FOR NEW SCENES

4,5,A, B. Introduction -- To try to convey the idea that there were thousands of different kinds of materials (organic and inorganic). To make the introduction a teaching part of the film, too.

C. Introductory Organizational Outline -- To structure their thinking for what was to come. To furnish a mental set.

16. To try to enhance the parallel drqwn that letters form words like atoms form new substances and at the same time reinforce and prepare for the periodic table of atoms.

17-23. New chart used because its title was easier to see and under each symbol the name was spelled out. Used to reinforce audio.

25-28. Dr. Mueller's footage was used to replace footage that was in error, not scientifically correct.

29. To reinforce the audio and emphasize the fact that scientists could build models, show how it was done, to illustrate how atoms combine into molecules, that atoms are almost never found separately but in combination. CO_2 was used since it was only vaguely mentioned in the original.

37. Sand model was used instead of the sugar model since this scene preceded the animated description of how large was a molecule of sand.

39. Again the assembling of the H_2O model to see relationship -- how they go together -- pointing up the number of different atoms.

41-48. To clearly identify each liquid and associate the formula and model with its name.

E. To tie in the new section with the old and introduce the new -- to see the progressive development involved.

F. To show that elements of the same thing emit in different forms.

62. Sugar jar labeled for identification, emphasis, and deliberate movements to set the stage for the sequence.

65, G.
49-52. The electrolysis process was reshot because the labels in the original were not always shown accurately in relation to the hydrogen and oxygen accumulated gases. To point up the idea of electricity being used and point out the valance of O_2.

71. Same basically as 62.

H, 76. To point out more clearly that paint was a mixture. Paint and wood were overlapped and seemed confusing in the original in trying to convey that both were mixtures.

I-P. Summary to recapitulate in an organized way what the three basic divisions were in the film and review and clearly identify the elements, compounds, and mixtures referred to in the film.